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Exploitation of newer botanicals as rice grain protectants against Angoumois grain moth, *Sitotroga cerealella* Oliv.

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ABSTRACT: Twenty eight plant products (oil, leaf powder or fruit powder) were evaluated as paddy grain protectants against Angoumois grain moth, *Sitotroga cerealella* Oliv. (Lepidoptera: Gelechiidae) as prophylactic treatment and post-phylactic treatment under controlled conditions of infestation. Under propylactic treatment, among the oils, spearmint, cotton seed, linseed and eucalyptus showed absolute grain protection, when admixed with the seed @ 0.50 & 1.00% v/w, whereas oils of karanj, mahua and polang gave absolute protection at 1.00% and kusum also came on par. In the post-phylactic treatment, eucalyptus oil showed absolute grain protection at 0.5 & 1.0% v/w up to 90 days. Spearmint oil (1.0% v/w) showed 100% inhibition in moth multiplication up to 180 days. Among, leaf powders (0.5 & 1.0% w/w) *Hyptes sauvelobens* and *Mikania cordata* showed significant reduction in population as prophylactic treatment up to 180 days, but none could absolutely check the incidence. Pest population was reduced by 100% in treatment with dried fruit of raja mircha and eucaplyptus leaf powder, whereas fruit powder of *Litsea cubeba* and black pepper showed promising reduction in moth population but failed to check its population multiplication absolutely. © 2006 Association for Advancement of Entomology

KEYWORDS: *Sitotroga cerealella*, botanical grain protectants, *Litsea cubeba*, *Hyptes sauvelobens*, *Mikania cordata*, *Eucalyptus* sp.

INTRODUCTION

Use of botanical pesticides is one of the important alternatives to minimize or replace the use of synthetic pesticides. A number of indigenous plant products have been earlier tested as paddy grain protectants against storage insects (Prakash *et al.*, 1980, 1981a,b, 1982, 1983, 1990a; Rao and Prakash, 2001, 2002; Tewari *et al.*, 1990) and some of the effective botanicals like leaves of *Vitex negundo, Lippia geminata, Aegle marmelos* and *Ocimum canum* have also been recommended for the management of rice storage in insect in rural India (Prakash and Rao, 1984, 1986, 1995). There

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TABLE 1. Adult population of *S. cerealella* in paddy grains treated with different vegetable oils

Botanical oils	Prophylactic 90 DAR 0.5% v/w	Prophylactic 90 DAR 1.0% v/w	Treatment 180 DAR 0.5% v/w	Treatment 180 DAR 1.0% v/w
Karanja, *Pongamia glabra* Vent.	4.58	0.70	9.08	0.70
(Fabaceae)	(20.50)	(0.00)	(82.00)	(0.00)
Kusum, *Carthamus tinctorius*	18.05	1.65	29.11	27.70
Linn. (Asteraceae)	(325.40)	(2.24)	(847.00)	(767.00)
Polang, *Calophyllum inophyllym*	4.39	0.70	8.84	0.70
Linn. (Clusiaceae)	(18.80)	(0.00)	(77.80)	(0.00)
Mahuwa, *Madhuca indica* J. F. Gmel	6.20	0.70	12.22	3.27
(Sapotaceae)	(38.80)	(0.00)	(149.00)	(10.20)
Palm, *Elaeis guineensis*	17.67	16.74	31.29	27.50
Jacq. (Palmaceae)	(312. 00)	(280.00)	(979.00)	(756.00)
Spearmint, *Mentha spicata* (Linn.)	0.70	0.70	0.70	0.70
Huds. (Lamiaceae)	(0.00)	(0.00)	(0.00)	(0.00)
Linseed, *Linum usitatissimum* Linn.	0.70	0.70	0.70	0.70
(Linaceae)	(0.00)	(0.00)	(0.00)	(0.00)
Cotton-seed, *Gossypium hirsutum* Linn.	0.70	0.70	0.70	0.70
(Malvaceae)	(0.00)	(0.00)	(0.00)	(0.00)
Corn, *Zea mays* Linn.	11.22	5.40	20.60	9.38
(Poaceae)	(125.60)	(28.80)	(424.00)	(87.60)
Bran of rice, *Oryza sativa* Linn.	17.94	15.54	34.50	30.07
(Poaceae)	(321.60)	(241.00)	(1190.0)	(904.00)
Nilgiri tel, *Eucalyptus globulus* Labill.	0.70	0.70	0.70	0.70
(Myrtaceae)	(0.00)	(0.00)	(0.00)	(0.00)
Control	18.00	18.00	31.94	31.94
No oil treatment	(323.80)	(323.80)	(1020.0)	(1020.00)
CD at 5%	2.23	1.98	5.90	5.07
1%	3.01	2.78	7.26	6.83
SE (m) ±	0.97	0.73	2.01	1.69

Data in parenthesis are original population mean of $\sqrt{x} + 0.5$ transformed values; DAR = Days after insect release.

is a need to search for more indigenous and effective botanical grain protectants. Therefore, we evaluated twenty eight indigenous botanicals against *S. cerealella* under laboratory, as prophylactic and post-phylactic treatments.

MATERIAL AND METHODS

Plant products (Tables 1 to 4) were collected from NBPGR Centre, Cuttack; Plant Resource Centre, Bhubaneswar, Nandankanan Botanical Garden and Medzephema, Nagaland during 2002–2004. Oils and leaf and fruit powders of selected plants were prepared in the Grain Entomology Laboratory, CRRI, Cuttack and tested using two kinds of treatments i.e. prophylactic (preventive) and post-phylactic (curative)

TABLE 2. Adult population of *S. cerealella* in paddy grains treated with different vegetable oils

Botanical oils	Post-phylactic Treatment			
	90	DAR	180	DAR
	0.5% V/W	1.0%V/W	0.5% V/W	1.0%V/W
Karanja,	5.52	1.58	10.44	3.17
Pongamia glabra	(30.00)	(2.00)	(108.60)	(9.60)
Kusum,	16.41	14.11	25.14	23.15
C. tinctorius	(268.80)	(198.80)	(632.00)	(535.60)
Polang,	11.42	7.44	16.07	12.70
C. inophyllym	(130.00)	(55.00)	(258.00)	(161.00)
Mahuwa,	11.81	9.43	22.38	18.39
Madhuca indica	(139.00)	(88.60)	(500.60)	(338.00)
Palm,	15.31	14.50	24.74	21.87
Elaeis guineensis	(234.00)	(210.00)	(612.00)	(478.00)
Spearmint,	1.97	0.70	2.38	0.70
Mentha spicata	(3.40)	(0.00)	(5.20)	(0.00)
Linseed,	7.79	2.25	15.61	10.41
L. usitatissimum	(60.20)	(4.60)	(243.40)	(108.00)
Cotton-seed,	1.58	0.70	3.67	0.70
G. hirsutum	(2.00)	(0.00)	(13.00)	(0.00)
Corn,	14.37	12.58	26.67	22.08
Zea mays	(206.00)	(158.00)	(711.20)	(487.20)
Bran of rice,	16.44	15.04	28.26	27.75
Oryza sativa	(270.00)	(226.00)	(810.00)	(770.00)
Nilgiri tel,	0.70	0.70	5.37	0.70
E. globulus	(0.00)	(0.00)	(28.40)	(0.00)
Control	19.09	19.09	29.57	29.57
No oil treatment	(364.00)	(364.00)	(874.00)	(874.00)
CD at 5%	2.52	2.09	5.28	5.49
1%	3.41	2.90	7.01	7.43
SE (m) ±	1.01	0.88	1.81	1.92

Data in parenthesis are original population mean of $\sqrt{x} + 0.5$ transformed values; DAR = Days after insect release.

treatments at 0.5% and 1.0% in v/w and w/w bases with paddy grains of variety Ratna, which is known to be highly susceptible to *S. cerealella*.

Under prophylactic treatment, oil treatment to the grains was given to the sterilized grains free from infestation of test insect and grains were stored in plastic containers of 1 kg capacity covered with fine muslin. Five pairs of newly emerged adults of *S. cerealella* were released in each container, which contained 500 g grains and each treatment had 4 replications including control. Under post-phylactic treatment, grains were treated with botanical oils only after commencement of infestation by the test insect, manifested artificially. Initial grain moisture was adjusted as 16%, which ranged later 16–17.5% throughout the experimental period. Observations on

TABLE 3. Adult population of *S. cerealella* in paddy grains admixed with leaf powder of different plants as prophylactic treatment

Leaf powders	Prophylactic treatment			
	90	DAR	180	DAR
	0.5% w/w	1.0%w/w	0.5% w/w	1.0%w/w
Goat weed, *Ageratum conyzoides*	8.86	4.90	17.50	9.02
Linn. (Asteraceae)	(78.50)	(23.60)	(306.00)	(81.00)
Malabar nut tree, *Adhatoda vasica*	11.59	7.59	22.37	16.26
Nees. (Acanthaceae)	(134.00)	(57.20)	(500.00)	(264.00)
Indian liquio rice, *Abrus*	11.85	7.30	23.22	14.78
precatorius Linn. (Fabaceae)	(140.00)	(52.80)	(239.00)	(218.00)
English basil, *Hyptes sauvelobens*	5.48	2.54	11.62	4.59
(Linn.) Poit. (Labiatae)	(29.60)	(6.00)	(134.60)	(20.60)
Mikania, *Mikania cordata* (Burm. f.)	5.57	2.91	11.85	5.04
B.L. Robinson (Compositae)	(30. 60)	(8.00)	(140.20)	(25.00)
Java devil pepper, *Rauvolfia*	16.70	14.78	30.07	27.69
serpentina Benth ex. Kurz.	(278.40)	(218.00)	(904.00)	(766.60)
(Apocynaceae)				
Rauvolfia tetraphylla Linn.	15.80	14.08	29.23	27.22
(Apocynaceae)	(249.40)	(198.00)	(854.00)	(740.60)
Chita (Hindi), *Plumbago zelanica*	14.98	12.52	28.00	26.39
Linn. (Plumbaginaceae)	(224.00)	(156.40)	(784.00)	(696.00)
Gulancha (Hindi), *Tinospora*	14.92	10.27	27.67	24.09
cordifolia (Willd.) Miers ex. Hook.	(224.40)	(105.00)	(765.40)	(580.00)
F. Thoms. (Menispermaceae)				
Control	18.00	18.00	31.94	31.94
No leaf admix	(323.80)	(323.80)	(1020.0)	(1020.00)
CD at 5%	2.09	1.83	5.22	5.08
1%	2.81	2.49	6.64	6.33
SE (m) ±	0.72	0.64	1.76	1.83

Data in parenthesis are original population mean of $\sqrt{x} + 0.5$ transformed values; DAR = Days after insect release.

adult emergence were made on 90th and 180th day after insect release (DAR) and data thus obtained were subjected to statistical analysis.

Further, in a separate experiment (2004) eight plant formulations at 1% concentration were tested against *S. cerealella* adopting the above procedure. In case of raja mirch, *Capsicum* sp. (collected from Nagaland), its whole dry fruit was placed on the grains @ 2 fruits/500 g grains. Ten pairs of newly emerged moths were released in each container (Table 4). Moth populations emerged at 45th and 90th days after insect release were counted, converted and analyzed as test parameter to assess bio-efficacy of the plant formulations.

RESULTS AND DISCUSSION

Results on eleven newer plant origin oils tested at both 0.5 and 1.0% v/w doses as paddy seed protectants under controlled conditions of infestation of *S. cerealella* for 90

TABLE 4. Efficacy of prophylactic botanical treatment against *S. cerealella*

Botanical formulations	Moth population* 45 DAR	Moth population* 90 DAR
Leaf of neem (*Azadirachta indica*) Cuttack	11.88 (140.75)	23.22 (239.00)
Eucalyptus leaf powder (*Eucaplyptus* sp.)	0.70 (00.00)	0.70 (00.00)
Black pepper powder (*Piper nigrum*)	5.07 (25.25)	5.57 (30.60)
Raja Mircha (*Capsicum sp.*) Nagaland	0.70 (0.00)	0.70 (00.00)
Leaf powder of Dhatura (*Datura metel*)	14.33 (205.0)	14.92 (224.40)
Leaf powder of marigold (*Tagetes erecta*)	12.27 (150.25)	16.26 (264.00)
Fruit powder of *Litsea cubeba* (Nagaland)	5.87 (34.00)	10.27 (105.00)
Leaf powder of *Litsea cubeba*(Nagaland)	10.15 (101.00)	17.50 (306.00)
Parad tablets (2 tabs/container)	0.70 (0.00)	0.70 (00.00)
Deltamthrin 2.5% WP @ 1g/kg	0.70 (0.00)	0.70 (00.00)
Control	20.38 (415.00)	30.07 (904.00)
CD (5%)	3.64	4.56
SEM ±	1.29	1.54

DAR = Days after release of the initial population of moth * = $\sqrt{x} = 0.5$ transformation of original data in parentheses: a mean of 4 replications.

and 180 days, are presented as prophylactic (preventive) treatment in Table 1 and also as post-phylactic (curative) treatment in Table 2. Under prophylactic treatment, the first four oil formulations *viz.*, spearmint, cotton seed, linseed and eucalyptus showed absolute grain protection against *S. cerealella* (100% inhibition of adults emergence), when admixed with the seed @ 0.50 & 1.0% v/w, whereas oils of karanj and polang gave absolute protection only at higher dose of 1.0% v/w and mahua also came on par with it.

Earlier, Srivastava *et al.* (1988) reported spearmint oil to show repellent activity against pulse beetle, *Callosobruchus chinensis* in redgram. Cotton seed oil was also found to protect maize, sorghum and wheat grains from attack of *S. cerealella* for 120 days (Oca *et al.*, 1978). Linseed oil cake reduced oviposition of rice weevil, *Sitophilus oryzae* (Bowry *et al.*, 1984). Eucalyptus oil tested earlier against *S. cerealella* on stored rice could check its cross infestation (Dakshinamurthy, 1988) and also showed repellency to rice moth, *Corcyra cephalonica* (Devaraj Urs and Srilatha, 1990).

In the post-phylactic treatment against *S. cerealella* (Table 2) only eucalyptus oil showed 100% inhibition in multiplication of this moth at both 0.5 and 1.0% v/w up to 90 days, whereas inhibition in moth multiplication up to 180 days was recorded only at 1.0% v/w. Spearmint oil treatment 1.0% v/w also showed 100% inhibition in moth multiplication up to 180 days. Other oil treatments could not absolutely check multiplication of the test insect at any of the test doses even for 90 days.

Data presented in Table 3 revealed that leaf powders of *Ageratum conyzoides, Hyptes sauvelobens* and *Mikania cordata* significant reducted population build up of *S. cerealella* at both 90 and 180 days of storage but none could absolutely check the multiplication of the test insect. Biological activity of leaf powders of *Hyptes*

sauvelobens and *Mikania cordata* against *S. cerealella* is reported for the first time. However, earlier Roy and Pandey (1991) reported toxicity in aqueous leaf extract of *H. sauvelobens* against aphid, *Lipaphis erysimi* on cabbage leaf. Rao and Prakash (2001) earlier reported that leaf powder of *A. conyzoides* showed significant grain protection against *S. cerealella, S. oryzae* and *Rhizopertha dominica* under controlled and natural conditions of infestation in stored rice.

Of eight kinds of plant materials (5 leaf powders; 2 fruit powder and one dry fruit as a whole) tested (Table 4) using only one dose *viz.*, @ 1% w/w admixed with stored paddy, only whole dried fruit of raja mircha and leaf powder of eucaplyptus showed 100% control of the population multiplication of *S. cerealella*. Fruit powder of *Litsea cubeba* and black pepper also showed promising reduction in population but failed to check population multiplication absolutely. Parad tablets and deltamethrin W.P. have been included in this experiment as check to compare the results, which also controlled population multiplication of *S. cerealella* by 100%.

Prakash and Rao (1997) reported traditional use of red chillies, *Capsicum annum* in Andhra Pradesh to protect stored rice from insect attack. In the present study, biological activity of raja mirch, *Capsicum* sp., a highly pungent spice has been reported for the first time as post-phylactic treatment against *S. cerealella* in stored paddy. Zhang and Zhao (1983) reported topical application of volatile essences of *Litsea cubeba* to kill adults of *Sitophilus zeamais* and *S. oryzae*. In the present study, *L. cubeba* has been reported to show biological activity. Fruit powder of black pepper admixed with milled rice was earlier reported to protect rice from the infestation of *S. oryzae* and *R. dominica* for 90 days (Prakash *et al.*, 1990b, 1991) and against *S. cerealella* in stored paddy (Prakash *et al.*, 1989). Present results on grain protection activity of fruit powder of black pepper against *S. cerealella* are in conformity with Prakash *et al.* (1989).

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Improvement of parthenogenetic development in the eggs of some parthenogenetic lines of the mulberry silkworm, *Bombyx mori* L.

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ABSTRACT: Parthenogenetic development was induced by subjecting the excised unfertilized eggs to hot water (46 °C) treatment for 18 min of three bivoltine and two polyvoltine parthenogenetic lines of silkworm, *Bombyx mori* L. Parthenogenetic development was more pronounced in bivoltine parthenogenetic lines compared to polyvoltine lines. Eggs extracted from 3 day-old female moths exhibited higher parthenogenetic development and hatchability compared to eggs from 1 and 2 day-old female moths. A higher humidity range (90–95%) was more favourable than lower ranges (75–80%) for development and hatching. Importance of this study in the development of homozygous silkworm breeds is discussed.
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KEYWORDS: *Bombyx mori* L., hatchability, parthenogenetic development

INTRODUCTION

Induction of artificial parthenogenesis by means of activation with various physico-chemical stimuli such as hydrochloric acid, low temperature, high temperature, alternating current, CO_2, laser beam etc on the unfertilized ova of the mulberry silkworm, *Bombyx mori* L. has been widely used in the development of homozygous silkworm breeds (Astaurov, 1957; Xu *et al.*, 1990, 1995; Hirokawa, 1995; Ravindra *et al.*, 2004. Exploitation of hybrid vigour to a greater extent depends on the homozygous nature of the breeds involved (Strunnikov, 1986; Nacheva *et al.*, 1999). Practical advantages of artificial parthenogenesis in hybrids comprising parthenoclone as a component showed more viability, hybrid vigour, combining ability and phenotypically uniform population (Strunnikov *et al.*, 1982; Strunnikov, 1986; Takei *et al.*, 1990; Ravindra *et al.*, 1994). Mechanism of hybrid vigour through artificial parthenogenesis has been analyzed (Ohkuma, 1971). Utilization of artificial parthenogenesis in the silkworm breeding has been realized by the breeders and reviewed by many workers (Strunnikov,

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1975; Chowdhury, 1989; Ravindra *et al.*, 1997; Klimenko, 2001; Gangopadhyay *et al.*, 2005). Recently, the possibility of artificial parthenogenesis in the management of transgenic population of the silkworm has been put forward (Grenier *et al.*, 2004). This study was undertaken to know the effect of age of female moth and relative humidity during post activation period on the induction of artificial parthenogenesis in some parthenogenetic lines of the silkworm, *Bombyx mori* L.

MATERIALS AND METHODS

Three bivoltine parthenogenetic lines namely, DNB_7, DNB_8 and DNB_9 and two polyvoltine parthenogenetic lines namely, DNP_5 and DNP_6 maintained at Silkworm Breeding Laboratory, Central Sericultural Research & Training Institute, Mysore were utilized in the present study. One hundred cocoons from each parthenogenetic line showing cocoon weight, cocoon shell weight and cocoon shell ratio higher than the average values were selected. The cocoons were kept for moth emergence. Moths emerging simultaneously were isolated in separate containers. Eggs were extracted by squeezing the ovarian follicles. Eggs from 1, 2 and 3 day old moths were separately collected. Twelve hours after extraction, artificial activation was induced by immersing the unfertilized eggs in hot water at 46 °C for 18 minutes. Eggs were abruptly cooled in cold water at room temperature for 10–15 minutes. Then they were dried and kept at 15 °C for 3 days. With the appearance of reddish brown to dark brown pigmentation in the serosa, bivoltine eggs were subjected for acid treatment in hot HCl of 1.075 Specific Gravity for 5 minutes. The eggs were incubated in 2 lots, one under temperature of 25 °C and RH of 75–80% and the other under 25°C and 90–95% RH till hatching. Appearance of reddish-brown to dark-brown pigmentation in serosa was treated as induction of parthenogenetic development. The percentage of pigmented eggs in total number of eggs was e pressed as percentage of parthenogenesis and from number of larvae emerging from pigmented eggs percentage of hatching was computed.

RESULTS

Results presented in Table 1 shows variation among the parthenogenetic lines and eggs collected from moths of different age groups. Eggs obtained from moths of older age group (3 day-old) exhibited more pronounced parthenogenetic development. Development towards parthenogenesis was highest in DNP_5 (99.82%) followed by DNB_8 (87.78%) and DNB_9 (75.84%). A clear trend towards parthenogenetic development was observed and it was relatively high, medium and low among the age group of 3, 2 and 1 days, respectively. A similar trend was observed in a polyvoltine parthenogenetic line, DNP_5 and parthenogenetic development above 95% was recorded in all the age groups.

The highest hatchability was observed in the 3 day-old age group of the bivoltine parthenogenetic line DNB_8 (24.54%) and it was followed by DNB_7 (17.99%) and DNB_9 (16.13%) whereas in polyvoltine parthenogenetic line, the highest hatchability

TABLE 1. Parthenogenetic development and hatching in excised unfertilized eggs of different parthenogenetic lines of silkworm, *Bombyx mori* L. obtained from different age groups and maintained under temperature of 25 °C and varying humidity levels

Genotypes	Age of moth (in days)	Under RH of 75–80%			Under RH of 90–95%		
		Number of eggs treated	Parthenogenesis (%)	Hatching (%)	Number of egges treated	Parthenogenesis (%)	Hatching (%)
Bivoltine lines							
DNB_7	1	3115	31.46	05.61	2556	43.04	11.36
	2	2820	38.72	09.89	2685	49.72	19.03
	3	3410	40.76	17.99	3264	62.96	36.01
DNB_8	1	2871	64.75	08.34	2542	72.97	16.77
	2	2740	83.21	18.86	3205	89.36	36.31
	3	3110	87.78	24.54	3585	93.22	40.31
DNB_9	1	2860	51.05	01.37	2627	58.17	05.69
	2	3150	62.83	07.93	2834	79.85	14.67
	3	3270	75.84	16.13	2753	97.35	28.84
Polyvoltine lines							
DNP_5	1	3395	96.55	–	3447	98.43	03.48
	2	3825	98.82	03.84	3478	99.51	08.29
	3	3815	99.82	11.34	3581	99.83	14.55
DNP_6	1	3510	32.56	–		3373	65.02
	2	3234	50.71	–	3423	68.48	–
	3	3680	58.70	03.70	3456	75.06	05.74

(11.34%) was recorded in the eggs of 3 day-old moths of DNP_5. The data of the present study clearly revealed that in all the parthenogenetic lines hatching was relatively high in the eggs obtained from the 3 day-old females and it was followed by eggs from 2 and 1 day-old moths. In DNP_5 though the parthenognetic development percentage was high the hatching percentage was low (0–11.34%) under 75–80% RH.

Comparative performance of parthenogenetic development and hatching in excised unfertilized eggs of different parthenogenetic lines and of moths of different age groups maintained under 75–80% and 90–95% RH revealed that eggs from older moths had higher parthenogenesis percentage and hatching percentage. The parthenogenetic development and hatchability percentage increased when eggs were incubated at relatively higher humidity of 90–95%.

DISCUSSION

Response towards artificial parthenogenesis greatly varies among the silkworm breeds and its occurrence is normally low (Hirokawa, 1990, 1995; Takei *et al.*, 1990; Shinbo *et al.*, 1991; Ravindra *et al.*, 1994). The lower occurence of parthenogenetic reproduction compared to the normal might be due to the factors of insensitivity of some eggs to heat activation and the drastic condition needed for unfertilized eggs to undergo parthenogenesis (Grenier *et al.*, 2004). Various factors were reported earlier as suitable for successful artificial parthenogenesis. Two factors namely age of female moth and post-activation care at different humidity regimes were considered in the present study. It was found that parthenogenetic development and hatchability were correlated positively with the female age and better performance towards parthenogenesis and hatchability was observed at higher relative humidity. Grenier *et al.* (2004) reported comparatively higher hatching of parthenogenetic eggs from older females.

By parthenogenetic reproduction, the breeds obtain genetic stability and they are highly useful for breeding lines with restored diploidy of lower inbreeding depression without any reduction in quantitative characters (Astaurov, 1957; Retnakaran and Percy, 1985). The results of the present study demonstrate that unfertilized eggs extracted from 3 day-old females when incubated at higher relative humidity (90–95%) will result in higher parthenogenetic development and hatching and it will be beneficial to the silkworm breeders in the development of homozygous silkworm breeds.

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Genitalial morphology of some Macroglossinae (Lepidoptera: Sphingidae) from Shivaliks in Punjab (India)

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ABSTRACT: Genitalial morphology of seven species of Macroglossinae *viz.*, *Nepheles didyma didyma* Rothschild and Jordan, *Theretra clotho* (Drury), *Theretra alecto* (Linnaeus), *Theretra oldenlandiae* (Fabricius), *Hyles euphorbiae nervosa* (Rothschild and Jordan), *Hippotion celerio* (Linnaeus) and *Hippotion rafflesi* (Butler) was studied. Based on genitalial characters, a species identification key is also provided.
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KEYWORDS: Lepidoptera, Sphingidae, genitalia, India

INTRODUCTION

Hawk moths belonging to the family Sphingidae is represented by as many as one thousand three hundred and fifty-four species and subspecies on world basis, out of which, two hundred and four belong to India (D'Abrera, 1986). Prior to this, Bell and Scott (1937) gave an account of one hundred and eighty-three species of these moths from British India (Burma, Ceylon, Andamans, India). While doing so, authors have referred that one hundred and thirty-five species belong to East Himalayas, seventy-five from South India, sixty-two from West Himalaya, forty-nine from Burma and twenty-two from Andaman Islands. Sathe and Pandharbale (1999) enlisted thirteen species referable to six genera from western Maharasthra, including ghats. A general account of the life history has been given by Bell and Scott (1937). By and large, the previous works suffer from serious drawbacks as the genitalic account of different species either not mentioned or not amply clear. In view of above, the present communication deals with the description of genitalia of seven species of subfamily Macroglossinae. Besides reexamination of the wing venation, detailed structure of the male and the female genitalia has been given to improve the diagnosis of the genus.

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OBSERVATIONS

Family: Sphingidae

Subfamily: Macroglossinae

Tribe : Nephelini

Bell and Scott (1937)

***Nephele* Hübner**

***Nepheles didyma didyma* Rothschild and Jordan**

Male genitalia (Plate 1, Figs A–B)

Uncus long, slender, slightly curved, neck broad, arcurate from tip; tip rather more sclerotised; tuba analis present; gnathos short, horizontal with almost parallel sides, rounded apex, weakly sclerotised; tegumen less sclerotised, broad but short; vinculum broad U-shaped; saccus broadly U-shaped, weakly sclerotised; valvae sole-shaped, setosed, costa arcurate, apex rounded, large friction scales arranged in two rows on the dorso-lateral side of valvae; sacculus broad, well developed; harpe small, thick spine, less evenly curved hook, pointed apically; juxta plate-like, weakly sclerotised; aedeagus of moderate length, sheat armed at end with two dentate processes, the proximal long, curving round the mouth of sheath, other short and obtuse.

Female genitalia (Plate 1, Fig. C)

Ovipositor lobes of typical sphingid type, i.e. papilae with spine; posterior apophyses slightly longer than anterior apophyses, rod-like; ostium bursae long, sinuate free; genital plate small, weakly sclerotised, excepting the posterior-lateral edges, which are somewhat incrassate; ductus seminalis entering anteriorly to the corpus bursae; corpus bursae much elongated, signi long broad, rod-shaped with numerous dents on its surface.
Alar expanse : Male 64 mm; Female 68 mm.

Material examined

Punjab : Dist. Patiala; PUP, 250 m, 26.vi.2003, 1♀; 20.ix.2003, 1♂; Dist. Gurdaspur (Teh. Pathankot); Dhar, 650 m, 23.x.2001, 3♂♂.

Remarks

The phenon comprising of five specimens has been compared with the reference collection at IARI, New Delhi and has been identified as *Nepheles didyma* Fabricius (=*Nepheles hespra* Fabricius). Hampson (1892) has reported this species as *Nepheles hespra* Fabricius without making any comments on variations in different individuals. Bell and Scott (1937) have referred that the species has two forms i.e., *didyma* Fabricius and *hespera* Fabricius with a comment that it is distributed throughout India

PLATE-1

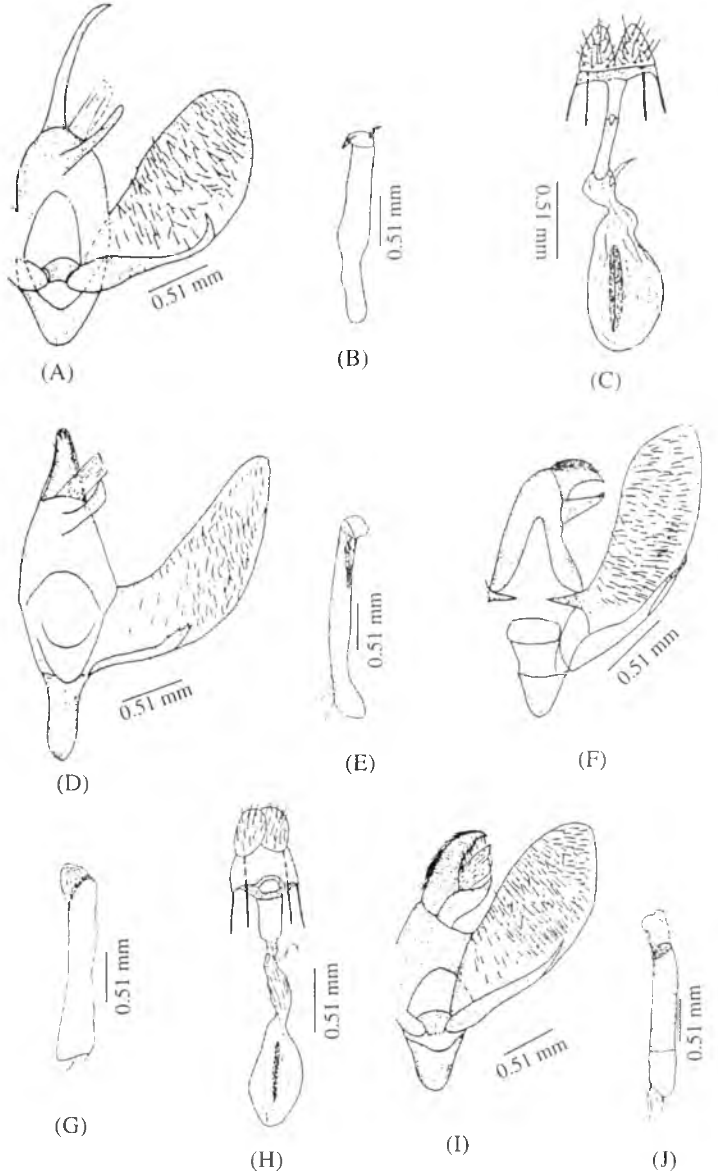

PLATE 1. *Nephele didyma didyma* Rothschild and Jordan: (A) Male genitalia – ventral view; (B) Aedeagus; (C) Female genitalia *Theretra clotho* (Drury): (D) Male genitalia – ventral view; (E) Aedeagus *Theretra alecto* (Linnaeus): (F) Male genitalia – ventral view; (G) Aedeagus; (H) Female genitalia *Theretra oldenlandiae* (Fabricius): (I) Male genitalia – ventral view; (J) Aedeagus.

being very common, especially in the plains. While photographing the specimens, D'Abrera (1986) has mentioned that the specimens used are figuring the two known forms on sexual dimorphism. The present examination of five specimens shows that the general colouration (maculation) of the female is slightly light in colour but there is no clear sexual dimorphism on the basis of the maculation of the wings. Further, in the present studies, it has been observed that there are some variations in the individuals collected from Dhar and Patiala as far as the arrangement of the spots on the dorsal surface of the forewings are concerned. In order to clear this ambugity, the males showing such variation were dissected and found to be completely conspecific. The nomencalture of the species as *N. didyma didyma* Rothschild and Jordan has been followed from D'Abrera (1986); Mehta (1933). Though, the later author has figured the male genitalia, very little description has been made about its constituent parts. Therefore, an illustrated account of the male and female genitlaia is given in the present work. It is note worthy to record that the female is highly species specific in having a specialised genital plate (small, weakly sclerotised, posterio-lateral edges somewhat incrassate) slightly projecting ostium bursae.

Tribe : Macroglossini Harris

Bell and Scott (1937)

***Theretra* Hübner**

***Theretra clotho* (Drury)**

Male genitalia (Plate 1, Figs D–E)
Uncus sinuate, basally broad, apically pointed, slightly bifid, tip heavily sclerotised decorated with long posteriorly direct seate, setae hair-like; tuba analis present; gnathos pointed heavily, chitinized at tip, tegumen braod, sclerotised, walls broadened width wise; vinculum U-shaped, saccus U-shaped broad, long; valvae sole shaped, simple, heavily setosed, costa slightly arched, sacculus margin thickened, given off into harpe, harpe without free process, truncate, dorsal edge more or less notched, juxta small; aedeagus much elongated, patch of teeth (dents) on penis sheath long, teeths pointing proximally, central point of each tooth long than lateral and curved, vesica membranous.
Alar expanse : Male 70 mm.

Material examined

Punjab : Dist. Gurdaspur (Teh. Pathankot); Dhar, 650 m, 23.x.2001, 1♂; Dist. Patiala; PUP, 250 m, 10.viii.1999, 1♂.

Remarks

The species, under reference, has been reported as *Cherocampa butus* Cramer with *Sphinx clotho* Drury as its synonym by Hampson (1892). According to the

characterisation given by Rothschild and Jordan (1903), it conforms to the genus *Theretra* Hübner because the second segment of the labial palpi has an apical tuft of scales directed ventrad and the apex of the first segment being densely and regularly scaled on the inner side with a cavity at the apex on the outer side (Holloway, 1987). It may also be mentioned that *clotho* Drury is the type-species of the genus *Hathia* Moore which along with *Oreus* Hübner, *Ganthostypsis* Wallengren, *Florina* Tutt and *Lilina* Tutt have been considered as a synonyms by Holloway (1987). According to D'Abrera (1986), the species is represented by two subspecies i.e., *Theretra clotho clotho* Drury (Oriental region, Timor) and *T. clotho cleleta* Butler (Moluccas, New Guinea, Solomons, Lifu, queensland and North of New South Wales) from the respective localities. Thus, the collection of the present sample from Shivaliks and the adjoining foot hill areas is new record, as it has already known from W. E. Himalayas, South India and Andamans (Bell and Scott, 1937).

Theretra alecto (Linnaeus)

Male genitalia (Plate 1, Figs F–G)

Uncus well developed, sinuate, sclerotised, setosed, apex pointed; gnathos much developed, spatulate chitinized, apex more heavily chitinized, uncus and gnathos fused basally; tuba analis present; tegumen long, broad, sclerotised, arms long, form a broad U-shaped; vinculum U-shaped, saccus long, broad U-shaped, weakly sclerotised; valvae long, simple, sole shaped, densely setosed, setae very fine, pointing towards costa innerside nearly straight basally, concave towards apex, apex rounded, sacculus margin sclerotised, produced into harpe; harpe long, slender, apex pointed, slightly curved apically, juxta broad plate; aedeagus long, slender, straight, sclerotised, vesica membranous, upper tip pointed, a long dentate curved process present at the orifice.

Female genitalia (Plate 1, Fig. H)

Ovipositor typical of sphingid type having numerous papillae; setae given off from each papillae; posterior apophyses much elongated than anterior apophyses; ostium bursae small, rounded, sclerotised, posteriorly elongated, surrounded with thickened plate; ductus seminalis enters near the origin of ductus bursae; ductus bursae membranous, rugose internally, elongated, almost of equal length of the corpus bursae, gradually given off in corpus bursae; corpus bursae big globular sac, signi elongate rod shaped, with numerous triangular dentate process scattered laterally.
Alar expanse: Male 82 mm; Female 86 mm.

Material examined

Punjab : Dist. Hoshiarpur; Dasua, 370 m, 15.x.1999, 1♀; Dist. Gurdaspur (Teh. Pathankot); Dunera, 700 m, 26.vi.2001, 2♂♂; Dist. Patiala; PUP, 250m, 23.viii.1998, 1♂; 4.viii.1999, 1♂; 5.viii.1999, 1♂; 18.viii.1999, 1♂; 9.ix.1999, 1♂; 15.ix.1999, 1♂; 19.ix.1999, 1♂; 6.x.1999, 1♂; 20.ix.2003, 1♂.

Remarks

According to D'Abrera (1986) and Holloway (1987), the species is widely distributed and have been reported from Greece, Egypt, Oriental region, Moluceas, Taimbar Islands, S.W. Asia. In India, it has been recorded from W.E. Himalaya and South India. According to Holloway (1987), the species lies in the low land areas between an altitude varying from 370 m to 700 m ASL. In the present studies, it has been collected from the area having an altitude of 250 m ASL.

***Theretra oldenlandiae* (Fabricius)**

Male genitalia (Plate 1, Figs I–J)

Uncus long, broad, well sclerotised, covered with thick setae, setae hair-like, directed backward; gnathos large, sclerotised, curved upwards; tuba analis present; tegumen long, broad, sclerotised; vinculum V-shaped, saccus U-shaped, weakly sclerotised; valva sole shaped, long, broad, setosed, medially very broad, apically rounded, costa slightly arched; sacculus margin oblique, margins sclerotised, harpe present, long, slender, pointed at apex; aedeagus long, slender, sheath with a leaf-like process present apically, process slightly dentate marginally.
Alar expanse : Male 60 mm.

Material examined

Punjab : Dist. Gurdaspur (Teh. Pathankot); Dhar, 650m, 23.x.2001, 5♂♂; Dunera, 700m, 26.vi.2001, 4♂♂; Dist. Patiala; PUP, 250m, 16.vii.1998, 1♂; 9.ix.1999, 1♂.

Remarks

Following D'Abrera (1986) and Bell and Scott (1937), the sample presently collected is represented by its nominotype as *Theretra oldenlandiae* (Fabricius), the nomenclature presently followed being correct.

***Hyles* Hübner**

***Hyles euphorbiae nervosa* (Rothschild and Jordan)**

Male genitalia (Plate 2, Figs K–L)
Uncus tapered, broader at base, setosed; tip more sclerotised; tuba analis present; gnathos well developed, sclerotised, curved, tip more heavily sclerotised rounded or obtusely acuminate; vinculum U-shaped; saccus U-shaped; valvae sole shaped, clothed with fine setae, costa even, apex weakly pointed, blunt, sacculus well defined, harpe present, slightly curved, tip pointed; aedeagus of moderate length, thick, a terminal process at the tip of apex, process dentate all along the edges.

Female genitalia (Plate 2, Fig. M)

Ovipositor lobes formed by a number of papillae, each emitting a spine; posterior apophyses longer than anterior apophyses; ostium bursae broad, sclerotised, forming an inverted bell-shaped structure; ductus bursae small, membranous, rugose anteriorly; ductus seminalis entering near the junction of ductus bursae and antrum; corpus bursae with a streak-like signum present.

Alar expanse : Male 58–75 mm.

Material examined

Punjab : Dist. Patiala; PUP, 250m, 21.vi.1998, 1♂; Dist. Gurdaspur (Teh. Pathankot); Dunera, 700 m, 26.vi.2001, 2♀♀, 2♂♂.

Remarks

Hyles Hübner is represented by thirteen species (Palaearctic 5 species), (Neotropical 3 species), (Madagascar 1 species), (Hawaiian 3 species) and Cosmopolitan (1 species) from various region of the world. The present sample represents the cosmopolitan species identified as *Hyles euphorbiae* Linnaeus. Further, the latter species is represented by five subspecies i.e., *H. euphorbiae euphorbiae* Linnaeus (Algeria, Tunisa, Europe), *H. euphorbiae conspicua* Rothschild and Jordan (Israel, Turkey, S.W. Arabia), *H. euphorbiae robertri* Butler (N.W. Himalaya, Pakistan, Kashmir, Afganisthan), *H. euphorbiae nervosa* Rothschild and Jordan (North India, S.E. Afganistan) and *H. euphorbiae costata* Nordman (Trans-Baisal, Eastern Siberia, North China) from the respective regions. Bell and Scott (1937) have reported the species, under refernece, from W. Hiamalayas (Ladakh; foot of Zoji-la Pass, Kashmir; Changla Gali; Sabathu) at an elevation of from 8,000 to 9,000 feet and its collection shows from the low land area of Shivalik mountains is an additional new record.

Hippotion Hübner

Hippotion celerio (Linnaeus)

Male genitalia (Plate 2, Figs N–O)

Uncus broad at the neck, tip slightly bifid, pointed, bent near apex, setosed laterally; gnathos large, strap-like, heavily chitinized, curved, pointed medially slightly curved upwards; tegumen broad, elongated, weakly sclerotised; valvae elongated, sole-shaped, margins sclerotised, densely setosed from middle to apex, less setosed basally; vinculum U-shaped; saccus U-shaped, weakly sclerotised; valva folded medially, costal margin nearly straight, apex rounded; sacculus broad, sclerotised, given off in curved processes comparable to harpe, which is slender, pointed at apex, apex slightly curved; lateral view of valva with a thick row of four spine-like setae; juxta small doom shaped; transtilla strap-like, weakly sclerotised medially and laterally; aedeagus of moderate length, sheath with a right apical row of teeths, a short left row which is sub apical.

PLATE-2

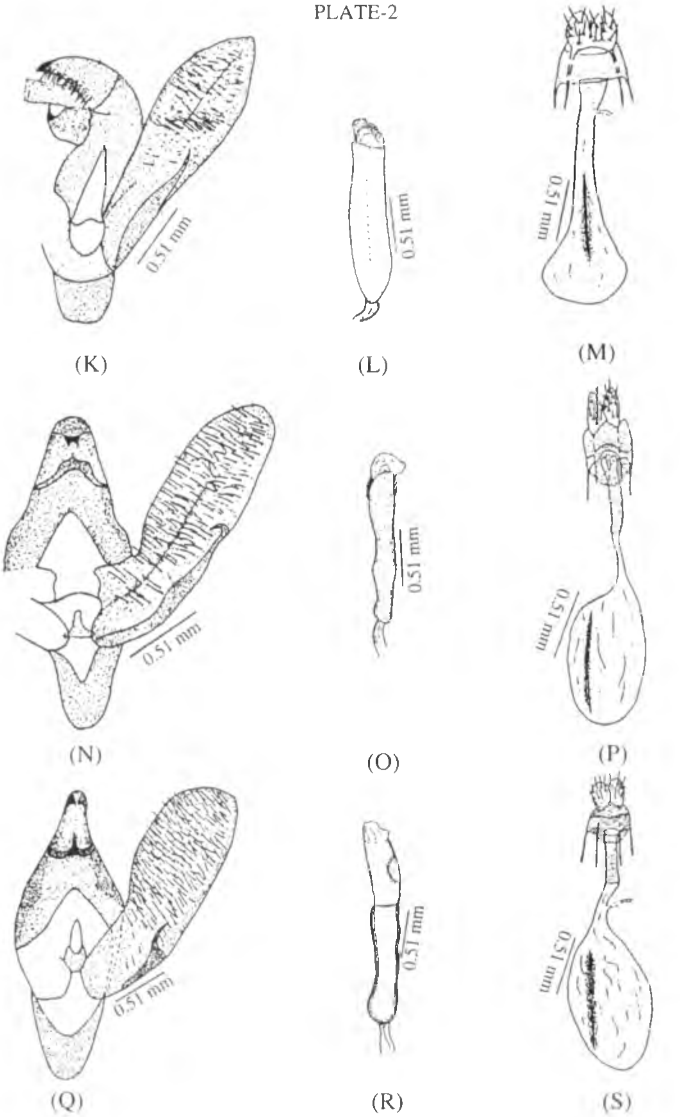

PLATE 2. *Hyles euphorbiae nervosa* (Rothschild and Jordan): (K) Male genitalia – ventral view; (L) Aedeagus; (M) Female genitalia *Hippotion celerio* (Linnaeus): (N) Male genitalia – ventral view; (O) Aedeagus; (P) Male genitalia *Hippotion rafflesi* (Butler): (Q) Male genitalia – ventral view; (J) Aedeagus; (S) Female genitalia.

Female genitalia (Plate 2, Fig. P)

Ovipositor lobes beset with numerous micropapillae typical sphingids; posterior apophyses oblong, anterior apophyses short; ostium bursae small, bilobed, elongated, sclerotised; guarded with an angular, free plate; ductus seminalis entering near the junction of ostium and ductus bursae; ductus bursae narrow anteriorly, sclerotised, wide, rugose interiorly, gelatinous outside; corpus bursae rugously scaled; signi simple, streak-like, rod-shaped, finely scobinated on either side by small dents.
Alar expanse : Male 62 mm; Female 75 mm.

Material examined

Punjab : Dist. Roopnagar; Nangal, 370m, 8.vii.2001, 6♂♂; Dist. Hoshiarpur; Dasua, 370 m, 15.x.1999, 1♂; Dist., Patiala, PUP, 250m, 3.iv.2000, 2♀♀; 20.iv.2003, 1♂.

***Hippotion rafflesi* (Butler)**

Male genitalia (Plate 2, Figs Q–R)
Uncus sharply sinuate, basally broad, slightly narrowed towards apex, apex tip toothed, (seem to be slightly bifid), gnathos triangular, narrowed at a point, apex curved upwards, almost hooked; tegumen broad, elongated, weakly sclerotised; vinculum U-shaped; saccus weakly sclerotised, broadly U-shaped; valvae long, narrower at base, broad medially; costa arched, apex rounded; sacculus with a well defined harpe; harpe short, rounded, with a short nearly terminal tooth; lateral view of valvae with a row of four thick scales; aedeagus long, slender, with a curved row of teeth on the left side, one to three teeths on right side.

Female genitalia (Plate 2, Fig. S)

Ovipositor lobes of typical sphingid type, each lobe formed by union of numerous papillae, each emitting a spine; posterior apophyses longer than anterior apophyses; ostium bursae with a plate above it, anterior and lateral edges of ostium bursae raised to a ridge which then gradually fades; ostium bursae small, caudal region of ostium bursae weakly sclerotised, forming an antrum; ductus bursae elongated, membranous, rugose internally, gelatinous outwardly, gradually broadening towards corpus bursae; ductus seminalis arising before middle, originating laterally; corpus bursae elongated, globular in shape, slightly rugose internally; signi a long streak-like, with fine scobination its either side.
Alar expanse : Male 55 mm; Female 60 mm.

Material examined

Punjab : Dist. Patiala; PUP, 250m, 2.ix.1998, 2♂♂; 7.ix.1998, 1♂; 31.vii.1999, 1♂; 15.ix.1999, 1♂; 28.ix.1999, 1♂; Dist. Gurdaspur; Teh. Pathankot; Dunera, 700m, 27.x.2001, 1♂; Dist. Hoshiarpur; Dasua, 370m, 15.x.1999, 3♂♂2♀♀.

Remarks

The species, under reference, has been considered as a synonym of *Chaerocampa theylia* Linnaeus by Hampson (1892). However, Bell and Scott (1937) have reported it as *H. rafflesi* (Butler), the nomenclature currently followed. The collection of the species from Dunera and Dasua (falling under Dist. Gurdaspur and Hoshiarpur respectively) for the Shivalik range in a new record.

DISCUSSION

During the course of present studies, two species i.e., *H. celerio* (Linnaeus) and *H. rafflesi* (Butler) have been collected from the Shivaliks in Punjab. The male and female gentialia of the type-species i.e., *H. celerio* (Linnaeus) have been briefly illustrated by Pierce and Berine (1938). The male genitalia of the same has been reexamined and it shows that the uncus is quite conspicuous, stout and slightly bifid apically, gnathos broad and narrowed down, distally into a sharp pointed process, valvae simple with well developed harpe. The other species namely, *H. rafflesi* (Butler) examined here completely conforms to the male genitalia of the type-species in the aforesaid genitalic characters. Hence, it is being inferred that both the species are highly congeneric. The congeneric nature of both the species is also evident from the structures such as the labial palpi, which are simple with first segment densely scaled at apex on inner side and second segment without apical tuft of scales. The closeness of these species is also evident from the female genitalia structures like ovipositor lobes, origin of the ductus seminalis from ductus bursae and well-developed rod-shaped, streak-like signa in the corpus bursae. Hampson (1892) considered *Hippotion* Hübner as a synonym of *Chaerocampa*, whereas, Bell and Scott (1937), D'Abrera (1986), Holloway (1987) and Pittaway (1995) have reported it as valid genus. As such, *Hippotion* Hübner contains more than 30 species from the different parts of the globe (D'Abrera, 1986). Out of these, only five species *viz*., *H. velox* Fabricius, *H. celerio* Linnaeus, *H. echeclus* Boisduval, *H. rafflesi* (Butler) and *H. boerhaviae* Fabricius are known from the Oriental region, including India (Bell and Scott, 1937). The male and female genitalia of two species i.e., *Hyles euphorbiae nervosa* (Rothschild and Jordan) and *Nepheles didyma didyma* Rothschild and Jordan of the genus *Hyles* Hübner and *Nephele* Hübner, respectively has been studied. Three species *viz*., *Theretra oldenlandiae* (Fabricius), *T. alecto* (Linnaeus) and *T. clotho* (Drury) have been dealt with in the present studies. Out of these, the former two species have been reported under the genus *Chaerocampa* Duponchel by Hampson (1892). While all the three under *Theretra* Hübner by Bell and Scott (1937), D'Abrera (1986), Liu and Yeh (1985); Holloway (1987). Besides, having specialised labial palpi, the present study shows that all the three species are highly congeneric owing to the characters such as uncus and gnathos well developed and the harpe being always present in male genitalia. The aedeagus has the cornuti arranged on a sheath in the species which otherwise can be distinguished on the basis of key, given below.

Key to the subfamilies of the family Sphingidae

1. Labial palpus without patch of sensory scales or hairs on inner surface of first segment; female genitalia with genital plate well developed........**Sphinginae**

– Labial palpus with a patch of sensory scales or hairs on the inner surface of first segment; female genitalia with genital plate reduced ....**Macroglossinae**

Key to the tribes of Macroglossinae

1. Labial palpus with tuft of scales of apex on the interior of second segment ....**Nephelini Rothschild and Jordan** (*Nephele* Hübner)

– Labial palpus with no tuft of scales at apex on the interior of second segment ....**Macroglossini Harris** **(*Theretra* Hübner, *Hyles* Hübner and *Hipption* Hübner)**

Key to the genera of tribe Macroglossini

1. Labial palpus with first segment densely scaled on inner side, with a cavity at apex on outer side.. ***Theretra* Hübner**

– Labial palpus with first segment densely scaled on inner side, without a cavity at apex on outer side **2**

2. Male genitalia with gnathos broad, boat-shaped, apex slightly pointed; female genitalia with ostium bursae broad, inverted bell shaped.........***Hyles* Hübner**

– Male genitalia with gnathos narrow, apex abruptly pointed; female genitalia with ostium bursae small, not bell shaped........................... ***Hipption* Hübner**

Key to the species of genus *Theretra* Hübner

1. Body colour greenish-brown, hindwing suffused with black at base; male genitalia with harpe without free process, truncate, dorsal edge more or less notched, aedeagus much elongated.. ***clotho* Drury**

– Body colour brown, hindwing not suffused with black; male genitalia with harpe simple, free process, thin elongated, pointed at apex, aedeagus of moderate length **2**

2. Abdomen with strong silvery white single or double strip, lateral patches at the base of abdomen; male genitalia with aedeagus having long dentate process at the tip.. ***alecto* Linnaeus**

– Abdomen with no silvery white strip and not lateral patches at the base of abdomen; male genitalia with aedeagus sheath with a leaf-like process, highly dentate marginally.................................... ***oldenlandiae* Fabricius**

Key to the species of the genus *Hippotion* Hübner

1. Hindwing with base bright pink; male genitalia with harpe not so well developed; female genitalia with ostium bursae bilobed anteriorly........ ***celerio* Linnaeus**
– Hindwing with base clayish-brown; male genitalia with harpe highly developed; female genitalia with ostium bursae rounded................. ***rafflesi* (Butler)**

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Two new genera and three new species of Languriidae from Nagaland, India (Coleoptera: Cucujoidea)

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ABSTRACT: *Pachylanguria rufoventris* n. sp., *Balidolanguria virgosus* n. gen. et n. sp. and *Indocladoxena rufus* n. gen. et n. sp. are described and illustrated from the northeast Indian State of Nagaland. Their distinction from the related taxa are also discussed. © 2006 Association for Advancement of Entomology

KEYWORDS: Coleoptera, Languriidae, New genus, New species, Nagaland

INTRODUCTION

Languriidae are a moderately large, well defined family of the section Clavicornia of the superfamily Cucujoidea. The languriids are small to large, elongate-oval to narrow-elongate, slightly flattened and often glabrous, with slender legs and clavate antennae. They are usually bicoloured or metallic and are commonly called 'lizard beetle'. The family with about 900 species have world-wide distribution but are found more commonly in the tropical parts of both the Old and New Worlds. Larvae of many species are stem borers and their adults feed on pollen or the foliage of the host plants. Following the publication of Arrow's Fauna in 1925 not much works have come out from the Indian subregion. Only recently, Sengupta and Mukherjee (1977, 1979, 1985) have dealt with the languriines of Himalaya and described a new genus from this part. Later, Pal (1992) recorded 3 species from Arunachal Pradesh in northeastern India, and Lyubarsky (1997) recorded a cryptophiline species from Uttar Pradesh. Recently, during the field work in Nagaland the beetles of this family were collected from the woodlands and vegetation that represent 2 new genera and 3 new species. The new taxa are described in this paper.

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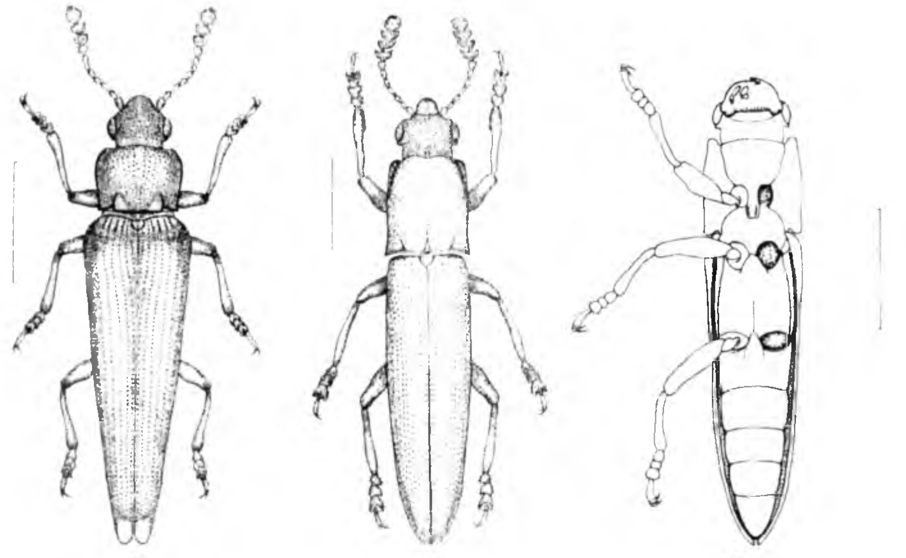


1 2 3

FIGURES. 1–3: 1, *Pachylanguria rufoventris* n. sp., Dorsal view (scale = 2.5 mm); 2, *Balidolanguria virgosus* n. gen et n. sp., Dorsal view (scale = 2.5 mm); 3, *Balidolanguria virgosus* n. gen et n. sp., Ventral view (scale = 2.5 mm).

SYSTEMATIC ACCOUNT

Family: LANGURIIDAE

Subfamily; LANGURIINAE

Genus *Pachylanguria* crotch

Pachylanguia Crotch, 1876, *Cist. Ent.* **1**: 377 (Type: *Languria paivae* Wollaston)

Diagnosis Facies elongate with moderately long antennae, head with finely facetted eyes, vertex with or without a pair of stridulatory files, 11-segmented antenna with 4-segmented club, mandible with bifid apex, maxillary lacinia tridentate, apical segment of maxillary palpi elongate, ligula broadly bilobed and apical segment of labial palpi elongate, transverse prothorax with distinct basal margin, front coxae moderately widely separated, prosternal process little produced behind coxae and with a pair of lateral grooves, elytra narrower posteriorly but not acuminate at apex.

Pachylanguria rufoventris n. sp.

Facies (Fig. 1) narrow-elongate, dorsally bright coppery-green, shining, sides of pronotum little lighter, glabrous, lower surface except apical part of the last abdominal ventrite reddish.

Head moderately large, transverse, no fronto-clypeal suture; puncturation on vertex moderately small, interspaces at least 4x as wide as punctures and those on clypeus little closer. Eyes moderately large, not projecting, finely facetted; vertex extended beneath eye like shelf, lateral margin of vertex bordering eyes finely bordered. Antenna moderately long, shorter than head and prothorax together, scape moderately large, pedicel slightly shorter and narrower than scape, segment 3 longer than segment 2 and subequal; segments 4–7 shorter than segment 3 and subequal; club 4-segmented, little asymmetrical, basal segment (segment 8) about as broad as long or little elongate, apical segments (segments 9–11) wider than basal one and transverse.

Prothorax transverse (1.0 : 1.2), widest little beyond middle and slightly narrowed both anteriorly and posteriorly, sides feebly arched, front angles obtuse and blunt, hind angles sharp and almost right angles, sides and base narrowly bordered, front non-bordered; pronotum finely punctate, almost similar to that of vertex of head; lateral foveae from the base of pronotum moderately long (shorter than one-fourth of pronotal length), base clearly impressed between lateral foveae. Scutellum smooth, little transverse and acutely pointed apically.

Elytra distinctly elongate (3.1 : 1.0), rather convex and narrowed from base to apex, base wider than prothorax and little emarginate medially, shoulder little carinate, without humeral carina, sides nearly straight, apical margins separately rounded and finely serrated, punctures on striae coarser than those on vertex and pronotum and usually separated by more than their diameter, scutellary striole present and about one-fifth as long as elytra.

On ventral side pro-, meso- and metasternum almost impunctate and abdominal ventrites very minutely and sparsely punctate, thorax an abdomen devoid of any coxal line, ventral surface entirely reddish except darker apical half of abdominal ventrite 5. Legs ventrally reddish and dorsally darker, apex of femora and base of tibia darker, tarsi darker.

Measurements of holotype

Total length 12.96 mm, width of head across eyes 1.92 mm, length of antenna 3.12 mm, length and width of prothorax 2.16 mm and 3.0 mm, length and width of elytra 10.02 mm and 3.24 mm.

Holotype

India: Nagaland, Kohima, above Forest Colony, 1470 m, 11.x.1998, T. K. Pal & party, *ex.* beating bush (Zoological Survey of India, Kolkata).

Etymology

The species-name refers to the largely reddish ventral surface of the body.

Remarks

This species comes close to *Panchylanguria impressicollis* (Kraatz) but can be distinguished by its transverse prothorax widest little beyond middle, little narrowed

both anterad and posterad; no coxal line on abdominal ventrite 1, and mesosternum not dark coloured but uniformly reddish.

***Balidolanguria* n. gen.**

Type-species: *Balidolanguria virgosa* n. sp. (by monotypy).

Description

Facies (Figs 2 and 3) elongated, moderately depressed, glabrous, head with finely facetted eyes, moderately long antennae with 4-segmented club, legs moderately long.

Head normal in shape, transverse; eyes moderately large, not projecting and finely facetted; vertex extended beneath eye like shelf, distinct fronto-clypeal suture, with a median stridulatory file on hind part of vertex. Antenna moderately long, slender, 11-segmented, antennal insertions somewhat dorso-lateral, scape moderately large and about as broad as long, segments 2–6 slightly narrower than scape and more or less elongate, segment 7 slightly wider than the preceding segment; club 4-segmented, moderately broad and slightly asymmetrical. Mandible with bifid tip, apical segment of maxillary palpi elongate and that of labial palpi transverse.

Prothorax elongate, rather convex, slightly wider posteriorly, front angles not produced and blunt, hind angles somewhat produced and acute, base and sides of pronotum distinctly marginated, base with transverse depression and a median and paired lateral foveae; front coxae moderately closely situated, coxal cavities nearly rounded, externally open behind, posternal process distinctly produced behind front coxae with nearly straight apical margin, prosternal process laterally sulcate, sterno-pleural suture extending to outer border of rim of prothoracic foramen.

Meso-metathorax: Mesocoxae more closely situated than front coxae, mesosternum between coxae narrower than coxal cavities, coxal cavities closed outwardly, sternal fitting between mesocoxae with a single knob from metasternum, metasternum about as broad as long, mesocoxal cavities with very short and slightly diverging coxal lines, median impressed line extending anteriorly to about half of metasternum, hind coxae separated wider than mesocoxae.

Elytra elongate, narrowed posteriorly, not broader at base than prothorax, somewhat excavated at base for reception of prothoracic base, apical margin separately rounded and minutely serrated, punctures arranged on linear striae, epipleurae not distinguishable.

Legs moderately long and slender, trochanters short and simple, femora somewhat swollen towards middle, tibiae slightly broadened at apex; tarsi 5-5-5, tarsal segment 1 little elongate, segment 2 broader than long, segment 3 about as broad as long and

lobed below, segments 1–3 somewhat dentate, segment 4 minute and arises from dorsal side of 3, segment 5 elongate and shorter than segments 1–3 together, claws simple.

Abdomen elongate, ventrites freely articulated, ventrite 1 longest and a bit shorter than metathorax, intercoxal process moderately broad and narrowed apically, with short and slightly diverging femoral lines, ventrites 2–4 subequal, ventrie 5 longer than 4.

Habitat: Foliage of shrubby vegetation.

Etymology: The generic name is an anagram of the closely related genus, *Labidolanguria*.

Distribution: India: Nagaland.

Remarks

This genus resembles *Labidolanguria* Fowler but can be distinguished by its finely facetted eyes, elytral apices separately rounded and not sharply acuminate or pointed.

Balidolanguria virgosus n. sp.

Facies (Fig. 2) narrow-elongate, subdepressed but dorsally rather covex, dorsally bright coppery green, shining, glabrous, lower surface except last abdominal ventrite reddish.

Head moderately large, transverse, widest across eyes; eyes moderately large, about half as long as head between apex of clypeus and orbital shelf, fronto-clypeal suture little arcuate, eyes separated by about 5.4x as wide as eye; puncturation on vertex moderately coarse and sparse, separated by 1.5 to 4x as wide as punctures, puncturation on clypeus denser. Antenna moderately long, slightly longer than prothorax, scape moderately large and about as broad as long, pedicel about as long as scape and narrower, segments 3–5 longer than pedicel and subequal, segments 6–7 shorter and slightly narrower than preceding segment; club 4-segmented, little asymmetrical, all segments broader than long.

Prothorax elongate (1.4 : 1.0), wider posteriorly and widest across hind angles, sides nearly straight and very feebly sinuate near posterior third, front angles blunt, hind angles acute and sharp; sides and base of pronotum bordered, sides finely and base little strongly, front except front angles non-bordered; median fovea at base about twice as long as lateral foveae, base clearly impressed between lateral foveae; puncturation on pronotum finer and sparser than those on vertex of head, punctures little coarser posterad.

Scutellum smooth, little transverse and acuminate apically.

Elytra distinctly elongate (3.4 : 1.0), widest just beneath base, rather convex and narrowed from base to apex; base about as wide as prothoracic base, emarginated medially and fit closely with prothoracic base, shoulders feebly carinate but without

humeral carina, sides nearly straight, apical margins separately rounded and minutely serrate; punctures on striae coarser than those on vertex and pronotum and usually separated by more than their diameter, no scutellary striole.

On ventral side prosternum with feeble transverse striations and scanty minute punctures, mesosternum, metasternum and abdominal ventrites minutely and sparsely punctate of which abdominal ones are little stronger; ventral surface reddish except last abdominal ventrite, prosternal borders and mesosternum which are darker. Legs including coxae chocolate-brown.

Measurements of holotype

Total length 16.44 mm, width of head across eyes 2.34 mm, length of antenna 3.96 mm, length and width of prothorax 3.84 mm and 3.12 mm, length and width of elytra 11.04 mm and 3.18 mm.

Holotype

India: Nagaland, Kukidolong, 245 m, 8 km. O-Medziphema, 28.x.1998, T. K. Pal and party, ex. beating bush; *Paratype*, 1 ex., same data as holotype (Zoological Survey of India, Kolkata).

Etymology

'Virgosus' means bush in latin, referring to the habitat of the species in bushy vegetation.

Subfamily: Cladoxeninae

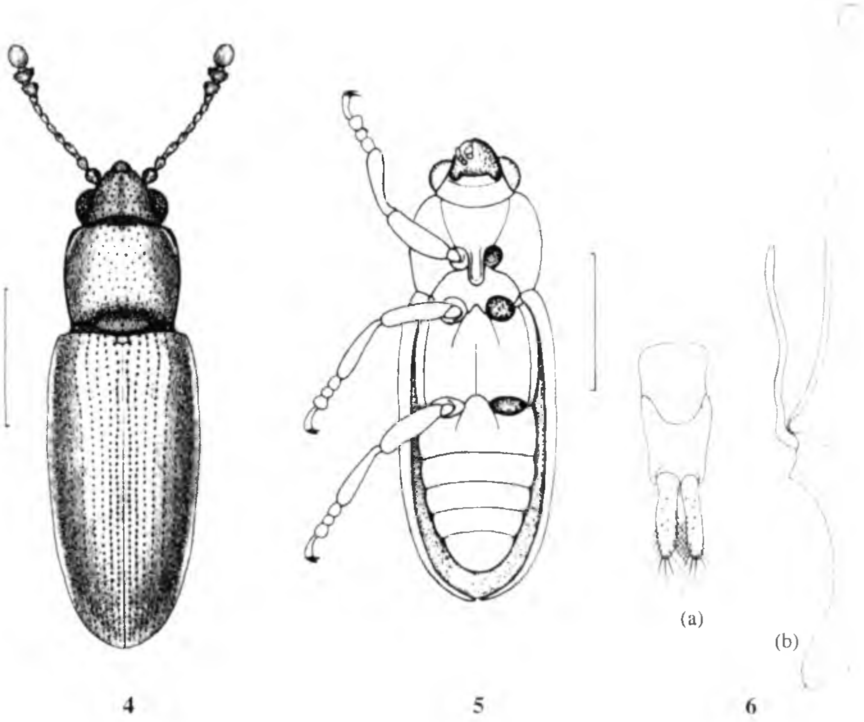
Indocladoxena n. gen.

Type-species: *Indocladoxena rufus* n. p. (by monotypy).

Description

Facies (Figs 4 and 5) elongated, moderately depressed, glabrous, elytra not very long in proportion to prothorax, head with coarsely facetted large eyes, moderately long antennae with 3-segmented symmetrical club, legs moderately long.

Head normal in shape, transverse; eyes large, moderately projecting, coarsely facetted; vertex not extended beneath eye like shelf, distinct fronto-clypeal suture, labrum partially exposed dorsally, no distinct stridulatory file on hind part of vertex. Antenna moderately long, slender, 11-segmented, antennal insertions somewhat dorso-lateral, scape moderately large and about as broad as long, segments 2–8 narrower than scape and more or less elongate; club 3-segmented, moderately broad with symmetrical. Mandible moderately large with bifid tip, apical segment of maxillary palpi elongate and that of labial palpi transverse.



FIGURES. 4–6: *Indocladoxena rufus* n. gen. et n. sp., Dorsal view (scale = 1.0 mm); *Indocladoxena rufus* n. gen. et n. sp., Ventral view (scale = 1.0 mm); *Indocladoxena rufus* n. gen. et n. sp. a, tegmen and parameters, dorsal view; b, median lobe and median strut, lateral view.

Prothorax about as broad as long, rather convex, sides rounded, front angles not produced, hind angles not produced but sharp, base and sides of pronotum finely bordered, base transversely impressed, paired lateral foveae pit-like or punctiform; front coxae moderately closely situated, coxal cavities nearly rounded, externally open behind, prosternal process produced behind front coxae with nearly straight apical margin, sterno-pleural suture extending to outer border of rim of prothoracic foramen.

Meso-metathorax: Mesocoxae more closely situated than front coxae, mesosternum between coxae narrower than coxal cavities, coxal cavities closed outwardly, sternal fitting between mesocoxae with a single knob from metasternum, metasternum transverse, mesocoxal cavities with moderately long and diverging coxal lines, median impressed line extending anteriorly up to about two-thirds of metasternum, hind coxae separated wider than mesocoxae.

Elytra elongate-ovoid, slightly broader at base than prothorax, somewhat excavated at base for reception of prothoracic base, apical margin not separately rounded, punctures on linear striae, epipleurae well developed and complete up to apex.

Legs moderately long and slender, trochanters short and simple, femora little swollen medially, tibiae slightly broadened at apex, tarsi 5–5–5, tarsal segment 1 a little elongate, segment 2 broader than long, segment 3 about as broad as long and lobed below, segment 4 minute and arises from dorsal side of 3, segment 5 elongate and shorter than segments 1–3 together, claws simple.

Abdomen elongate, ventrites freely articulated, ventrite 1 longest and somewhat shorter than metathorx, intercoxal process moderately broad and narrowed apically, with divergent femoral lines that extend almost up to middle of ventrite, ventrites 2–4 subequal, ventrie 5 longer than 4. Aedeagus (Fig. 6a, b) cucujoid-type, median lobe curve, tubular; median strut long, slender, thread-like and double; tegmen forming a ring with a large dorsal cap; articulated paired parameters slender, elongate and setose, setae longer apically.

Habitat: *Foliage of shrubby vegetation*

Etymology: The generic name is derived by placing the prefix 'Indo', referring to the country of occurrence, with 'Cladoxena'.

Distribution: India: Nagaland.

Remarks

This genus shows some similarity with the genera *Thalliseloldes* Arrow, *Paracladoxena* Fowler and *Cladoxena* Motshculsky. It differs from *Thallisellodes* by its base and sides of pronotum finely bordered, front angles of prothorax not produced, and apices of elytra not separately rounded. It differs from *Paracladoxena* by its prothorax broadest near middle, not quite contracted behind and basal margin trisinuate, larger eyes, coxal lines of metasternum and first abdominal ventrite diverging posteriorly. It differs from *Cladoxena* by its coarsely facetted eyes, prothorax not caudiform and not quite contracted behind, and apices of elytra not separately rounded.

Indocladoxena rufus n. sp.

Facies (Fig. 5) elongate, subdepressed but dorsally rather convex, reddish-brown, glabrous, shining, with large darker eyes.

Head moderately large, transverse, widest across eyes; eyes large, greater than half as long as head, prominent, separated by about 5x as wide as eyes, orbital margin of head bordered, fronto-clypeal suture little arcuate. Puncturation on vertex moderately coarse and sprase, separated by 1 to 4x as wide as punctres, puncturation on clypeus more densely arranged. Moderately long antenna slightly shorter than head and prothorax together, scape moderately large and about as broad as long, segments

2–8 narrower than scape, segment 3 longer than any other segment, club moderately broad, segments 9 and 10 little transverse and 11 elongate.

Prothorax little transverse (1.0 : 1.06), sides rounded, widest little beyond middle and slightly narrower both anteriorly and posteriorly, front angles not produced and bluntly obtuse, hind angles about right angles, sides and base of pronotum finely bordered, front margin non-bordered, base of pronotum clearly impressed between lateral foveolate punctures; puncturation on pronotum finer and sparser than those on vertex of head.

Scutellum smooth, transverse and somewhat rounded apically.

Elytra elongate (2.34 : 1.0), widest near middle, rather convex, base hardly broader than prothoracic base, emarginate medially and fit closely with prothoracic base, shoulders feebly carinate but without humeral carina, sides rounded, apex rounded and smooth, punctures on striae slightly coarser than those on vertex and usually separated by more than their diameter, no scutellary striole.

On ventral side prosternum with feeble transverse striations and scanty minute punctures; mesosternum, metasternum and abdominal ventrites minutely and sparsely punctate; mesosternum, metasternum and abdomen little darker than dorsal side; legs except coxae lighter than sternum and abdominal ventrites. Aedeagus as in figure (Fig. 6a, b).

Measurements of holotype Total length 2.74 mm, width of head across eyes 0.56 mm, length of antenna 0.96 mm., length and width of prothorax 0.66 mm and 0.70 mm, length and width of elytra 1.90 mm and 0.81 mm.

Holotype India: Nagaland, Dimapur, Rangapahar Wildlife Sanctuary, 130 m, 31.x.1998, T. K. Pal & party, ex: beating bush; *Paratype*, 1 *ex*. ♂, same data as holotype; aedeagus dissected, mounted on cover slip and pinned with the Paratype (Zoological Survey of India, Kolkata).

Etymology The species-name refers to reddish body colour of the individuals.

ACKNOWLEDGEMENTS

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Short Communication No. ent.31105

Bioefficacy of *Excoecaria agallocha* (L.) leaf extract against the armyworm *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae)

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ABSTRACT: Different organic solvent extracts of *Excoecaria agallocha* leaf had shown antifeedant, oviposition deterrent and ovicidal activities against *Spodoptera litura*. Maximum antifeedant (73.08%), oviposition deterrent (83.71%) and ovicidal (65%) activities were observed at 5% treatment of hexane extract. Seven fractions were obtained from hexane extract through column chromatography. Among the seven fractions, fraction 7 showed promising antifeedant (81%), oviposition deterrent (80%) and ovicidal (77%) activity at 1000 ppm. *E. agallocha* could be used in IPM.
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KEYWORDS: Bioefficacy, *Spodoptera litura*, *Excoecaria agallocha*, solvent extracts

Biopesticides have gained importance in recent plant protection technology. The present study was undertaken to assess the efficacy of extract of *Excoecaria agallocha* (a mangrove plant) against *Spodoptera litura*, a serious pest of more than 120 agricultural and forest plant species worldwide. Leaves of *E. agallocha* were collected from Kakinada (AP), shade-dried and powdered using electric blender. One kg of plant powder was soaked in hexane, chloroform and ethyl acetate respectively for 48 h at room temperature (28±2°C), then filtered, condensed, weighed and stored at 4°C until use. Hexane crude extract was fractionated through a silica gel (100-200 mesh LR) column chromatography (4cm × 60 cm) using hexane in combination with ethyl acetate (95:5; 90:10; 85:15; 80:20). Separation was confirmed using thin Layer Chromatography (on Aluchrosep Silica gel 60 UV254 gel coated Sheets); each fraction was tested for its bioactivity

Antifeedant activity of crude extracts/fractions was studied by no-choice method. Fresh castor leaf (*Ricinus communis*) discs dipped in different concentrations of extract fractions of the principal extract were tested against 2 h pre-starved fourth instar larvae of *S. litura*. For each treatment five replicates were maintained. The

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TABLE 1. Antifeedant, oviposition deterrent and ovicidal activity of different crude extracts of *E. agallocha* against 4th instar larvae of *S. litura*

Conc. (%)	Hexane	Chloroform	Ethyl acetate
	Antifeedant activity (%)		
0.625	24.47^a	12.34^a	28.25^a
1.25	40.34^b	23.54^b	34.37^b
2.5	56.30^c	41.76^c	46.00^c
5	73.08^d	48.44^d	57.96^d
	Oviposition deterrent activity (%)		
0.625	30.97	28.60	31.95
1.25	69.66^b	60.51^a	58.68^a
2.5	74.07^b	70.64^b	60.87^a
5	83.71^b	75.10^a	72.56^a
	Ovicidal activity (%)		
0.625	15.48^a	8.04^a	16.96^a
1.25	30.95^b	19.05^b	23.81^b
2.5	50.60^c	34.82^c	51.79^c
5	65.48^d	47.92^d	52.08^c

In each column, figures marked by the same alphabet are not significantly different ($P = 0.05$).

antifeedant activity was calculated by subtracting the area consumed in treated leaf disc from the area consumed in control and dividing this by the area consumed in control (Kabaru and Gichia, 2001).

Oviposition deterrent activity of crude extract/fractions were studied by spraying treatment solution on pot cultured castor plants placed inside the oviposition cage. Ten pairs of *S. litura* moths were introduced in a cage and 10% (w/v) sucrose solution was provided for adult feeding. Five replicates were maintained for each treatment. After 48 h, the number of egg masses laid on treated and control leaves were recorded. The percent oviposition deterrent activity was calculated by subtracting the number of eggs laid on treated plant from the number of eggs laid on control plant and dividing this by the number of eggs in control plant (Raja *et al.*, 2004).

Ovicidal activity: Scales from the egg mass were removed carefully and loosened eggs were dipped in different concentrations of crude extracts/fractions and they were allowed to air dry and kept for incubation. Ovicidal activity was calculated by subtracting the number of eggs hatched in treated plant from the number of eggs hatched in control plant and dividing this by the number of eggs hatched in control plant (Raja *et al.*, 2004).

Among the different extracts, hexane extract exhibited promising result followed by ethyl acetate and chloroform (Table 1). Highest feeding deterrence (73.08), oviposition deterrence (83.71%) and ovicidal activity (65%) were seen in 5% hexane extract. Effect of different fractions of hexane extract is presented in Table 2. Fractions 2

TABLE 2. Antifeedant, oviposition deterrent and ovicidal activity of different fractions of hexane crude extracts of *E. agallocha* against 4th instar larvae of *S. litura*

Fractions	Treatment (ppm)			
	125	250	500	1000
	Antifeedant activity (%)			
F1	21.23^{c}	35.18^{d}	44.71^{c}	56.10^{b}
F2	33.18^{d}	43.86^{e}	64.81^{f}	78.10^{c}
F3	22.00^{c}	30.93^{c}	43.74^{c}	54.43^{b}
F4	2.28^{a}	17.84^{a}	38.81^{b}	47.70^{a}
F5	13.40^{b}	30.91^{bc}	35.2^{a}	55.48^{b}
F6	12.53^{b}	27.91^{b}	52.22^{d}	56.74^{b}
F7	33.47^{d}	50.68^{f}	56.22^{e}	81.37^{d}
	Oviposition deterrent activity (%)			
F1	55.02^{d}	56.80^{b}	71.66^{bc}	71.00^{a}
F2	61.00^{e}	71.89^{d}	73.94^{c}	80.72^{c}
F3	57.07^{d}	58.81^{b}	68.36^{b}	75.95^{b}
F4	54.13^{d}	58.37^{b}	73.81^{c}	71.66^{a}
F5	18.16^{a}	33.24^{a}	54.71^{a}	73.63^{a}
F6	27.40^{b}	55.64^{b}	67.74^{b}	71.00^{a}
F7	46.36^{c}	64.12^{c}	73.76^{c}	75.46^{ab}
	Ovicidal activity (%)			
F1	18.39^{a}	33.33^{b}	52.30^{a}	66.67^{b}
F2	26.44^{b}	39.94^{d}	56.61^{b}	72.41^{c}
F3	26.72^{b}	6.61^{a}	56.90^{b}	72.70^{c}
F4	34.20^{c}	40.23^{d}	56.61^{b}	66.67^{b}
F5	25.57^{b}	35.34^{b}	51.72^{a}	61.78^{a}
F6	32.76^{c}	36.78^{bc}	54.02^{ab}	59.48^{a}
F7	33.91^{c}	43.10^{de}	60.63^{c}	77.30^{d}

In each column, figures marked by the same alphabet are not significantly different ($P = 0.05$).

and 7 showed good antifeedant (78–81%), oviposition deterrent (75.46–80.72) and ovicidal (72–77%) activity at 1000 ppm treatment. The plant products reduced the feeding duration and food ingested by larvae lead to abnormality in insect growth and development. Growth inhibition, malformation and mortality in larval, pupal and adult stages were also observed.

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Antifeedant activity of *Sphaeranthus indicus* L. against *Spodoptera litura* Fab.

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ABSTRACT: Methanol extract of *Sphaeranthus indicus* showed antifeedant activity against 4th instar larvae of *Spodoptera litura*. Among the compounds isolated from this fraction, 7-hydroxyfrullanoide had high antifeedant activity at 1000-ppm. Deformities in larvae, pupae and adult were also observed.
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KEYWORDS: *Sphaeranthus indicus*, 7-hydroxyfrullanoide, Thiophene-A, antifeedant, *Spodoptera litura*

Sphaeranthus indicus (family: Asteraceae; local name: *Kottakaranthai*) is known to possess many medicinal properties. The leaves of this plant is often mixed with paddy and rice to prevent pest damage during storage. So far there is no detailed report on biological activity especially antifeedant activity against insect pests. Hence the antifeedant activity of crude extracts and some compounds from *S. indicus* extract was assessed taking *Spodoptera litura* (Fab.) as a test insect.

The plant, *S. indicus*, was collected from the hills around Papanasam village, Tirunelveli District, Tamil Nadu and was air dried and ground in a Wiley grinder with a 2 mm wire mesh. The powder (35 g) was soaked in 500 ml of respective solvents (methanol, ethyl acetate, hexane) for 24 h with constant shaking. The sample was then suction filtered through Whatman #1 filter paper. The filtrate was evaporated to dryness under reduced pressure. The methanol extract was subjected to column chromatography over silica gel (300 g, silica gel 230–400 mesh, Merck) using a gradient of hexane in ethyl acetate. The column was finally washed with 50% ethyl acetate in hexane, followed by 100% ethyl acetate. The fractions were analysed by TLC and UV, and when single spots were seen, they were subjected to NMR. Hexane, ethyl acetate and methanol crude extract of *S. indicus*, the two compounds and 6th fraction obtained through column chromatography from methanol extract were tested for antifeedant activity against 4th instar larvae of *S. litura*. *S. litura* culture was established from the egg masses collected from vegetable fields at Padappai, near

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TABLE 1. Antifeedant activity of different crude extracts of *S. indicus* (expressed in percentage) against IV instar larvae of *S. litura*

Crude extracts	Concentrations			
	0.625%	1.25%	2.5%	5%
Methanol	10.53 ± 1.73^{b}	21.87 ± 1.91^{a}	62.94 ± 1.38^{b}	71.44 ± 1.57^{ab}
Ethyl Acetate	10.07 ± 1.84^{b}	19.93 ± 1.31^{a}	52.98 ± 1.65^{a}	68.83 ± 0.57^{a}
Hexane	7.12 ± 0.83^{a}	19.18 ± 1.53^{a}	55.71 ± 1.47^{a}	66.87 ± 1.58^{a}

Values are represented as Mean ± SD of five replications. Similar alphabets in a column indicate that there is no statistically significant difference at 5% level using LSD.

Chennai and reared in the Insectary, Entomology Research Institute as per standard procedure (Singh, 1985).

Antifeedant activity of crude extracts/ fractions was studied using leaf disc no choice method (Isman *et al.*, 1990). The stock concentration of crude extracts (5%) and fractions (1000 ppm) were prepared by dissolving in acetone and mixed with dechlorinated water. Polysorbate 20 (Tween 20) at 0.05% was used as emulsifier (Saxena and Yadav, 1983; Subramonithangam and Kathiresan, 1988). From the stock required concentrations were prepared and tested against *S. litura*. Fresh castor leaf (*Ricinus communis*) discs of 3 cm diameter were punched using cork borer and dipped in 0.625, 1.25, 2.50 and 5.0% concentrations of crude extracts and 125, 250, 500 and 1000 ppm concentrations of pure compounds and fractions individually. Leaf discs treated with acetone were considered as negative control. Pure azadirachtin and NeemAzal, a company product, were used as positive control.

After air-drying, each leaf disc was placed in petridish (1.5 cm × 9 cm) containing wet filter paper to avoid early drying of the leaf disc and single 2hr pre-starved fourth instar larva of *S. litura* was introduced. For each concentration ten replications were maintained. Progressive consumption of leaf area by the larva after 24 hr feeding was recorded in control and treated discs using leaf area meter (Delta-T Devices, Serial No. 15736 F 96, U.K). Leaf area consumed in plant extract treatment was corrected from the control. The percentage of antifeedant index was calculated using the formula of Ben Jannet *et al.* (2000).

The data collected were represented as Mean ± SD and One-way analysis of variance (ANOVA) was used to find out the least significant difference (LSD) ($p < 0.05$).

Altogether 25 fractions were collected from methanol crude extrat using column chromatography. Preparative TLC of fraction 4 yielded Thiophene–A which was confirmed by UV spectrum. This compound has been already reported (Bohlmann *et al.*, 1973). Preparative TLC of fraction 8 yielded 7-hydroxyfrullanoide, which was confirmed by NMR spectral analysis. This compound has also been already reported (Gogte *et al.*, 1986; Sohoni *et al.*, 1988; Attaurrahman *et al.*, 1989). Sixth fraction yielded a mixed spot even after preparative TLC and hence it was not subjected to NMR.

TABLE 2. Antifeedant activity of different fractions of *S. indicus* (expressed in percentage) against IV instar larvae of *S. litura*.

Compounds	125 ppm	250 ppm	500 ppm	1000 ppm
7-hydroxyfrullanoide	64.61 ± 17.0^c	70.45 ± 7.56^c	76.12 ± 6.81^b	86.09 ± 6.51^b
6th Fraction from methanol extract	43.81 ± 16.41^b	60.17 ± 9.81^b	73.25 ± 6.81^b	83.27 ± 10.07^b
Thiophene-A	43.46 ± 15.13^b	68.28 ± 6.44^c	71.85 ± 6.52^b	80.81 ± 7.6^b
Azadirachtin (40.86%)	61.19 ± 8.54^c	69.28 ± 6.44^c	77.85 ± 6.52^b	87.45 ± 4.60^c
Neem Azal – T/S (EC 1%) EID Parry	64.2 ± 4.58^c	71.22 ± 10.45^c	72.57 ± 6.70^b	80.91 ± 8.11^b
Solvent Control (Acetone)		39.92 ± 12.63^a		

Values are represented as Mean ± SD of 10 replications. Similar alphabets in a column indicate that there is no statistically significant difference at 5% level using LSD.

Data in Table 1 show that antifeedant activity was highest in all doses of methanol extract, though on par with other treatments at same levels. Data in Table 2 show that azadirachtin had higher activity than the other compounds and fraction tested. The percent antifeedant activity was higher in azadirachtin and on par with 7-hydroxyfrullanoide at all levels. The activity was lower in other treatments. Sixth fraction from methanol extract and Thiophene-A were on par and significantly inferior to 7-hydroxyfrullanoide at 125 and 250 ppm levels while at all other levels, all the treatments were on par. Deformities in larval, pupal and adult stages were also observed.

The present study indicates that methanol extract of *S. indicus* is promising in reducing the feeding rate of *S. litura*. The rate of feeding varied significantly depending on the concentration of the plant extract. 7-hydroxyfrullanoide showed promising antifeedant activity at all concentrations. It caused malformation and mortality in larval, pupal and adult stages. Similar findings were reported by many researchers in other plant extracts (Barnby and Klocke, 1990; Meniawi *et al.*, 1999; Mahesh Kumar *et al.*, 2001). Hence it is possible to use 7-hydroxyfrullanoide as a component in biopesticide formulations.

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Notes on the Indian species of the genus *Platythyrea* (Hymenoptera: Formicidae) with an identification key

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ABSTRACT: This paper provides a revised key (after Brown, 1975) to the Indian species of the ant genus *Platythyrea*. The present status of the Indian species of the genus is discussed. © 2006 Association for Advancement of Entomology

KEYWORDS: Hymenoptera, Formicidae, Ponerinae, *Platythyrea*

INTRODUCTION

The ant genus *Platythyrea* was described by Roger in 1863. Bingham (1903) subsequently designated *Pachycondyla punctata* Smith from St. Domingo (U.S.A.). Among the genera of the subfamily Ponerinae, *Platythyrea* is distinguishable by the presence of two pectinate spurs on hind tibia. This arboreal ant genus is represented from world tropics by 37 species including a fossil species, *P. primaeva* W. M. Wheeler (Bolton, 1995). Lattke (2003) described three new fossil species, *viz.*, *P. dentata, P. procera* and *P. scalprum* from Dominician Amber collection of the American Museum of Natural History, taking the total number of species to 40.

Taxonomy

1. *Platythyrea nicobarensis* Forel

Platythyrea nicobarensis Forel, 1905, *Annales de la Societe Entomologique de Belgique* **49**: 155–185. [Not examined]

Distribution

India: Nicobar Islands (Forel, 1905).

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Comments

Brown (1975) states that this species has elongated head, with deeply excavated posterior margin.

2. *Platythyrea parallela* Smith. F.

Platythyrea parallela Smith, F. 1859. *J. Proc. Linn. Soc. Lon., Zoology* **3**: 132–158.

Platythyrea wroughtonii Forel, 1900, *J. Bombay Nat. Hist. Soc.* **13**: 315, worker.

Platythyrea wroughtonii r. *victoriae*, Forel, 1900. *J. Bombay Nat. Hist. Soc.* **13**: 315–316.

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Platythyrea wroughtonii Brown, 1975. *Search Agriculture* **5**. Entomology (Ithaca) **15**: 8. (Synonymised with *parallela*).

Distribution

India: Bengal, Chennai Rothney (1889), Western India, Mysore, Travancore (Bingham, 1903) and Bangalore (Brown, 1975).

Material examined

Many workers, India: Bangalore, Sanky Lake, 8-xii-2004, Coli: A. K. Dubey (IWST).

Comments

This is an arboreal species. Individual workers of this species are collected from *Samanea saman* (rain tree).

3. *Platythyrea sagei* Forel

Platythyrea sagei Forel, 1900. *J. Bombay Nat. His. Soc.* **13**: 315.

Distribution

India: Punjab: Sage, Karnataka: Kanara (Bingham, 1903).

Material examined

Many workers, India: Karnataka: Kudremukh National Park, 3-v-2005, Coll: A. K. Dubey (IWST).

Comments

This species is unique among the known Indian species in having bidentate petiole (Bingham, 1903). Individual workers were found foraging on ground.

Revised key to the valid species from the Indian subcontinent is given below:

Key to the workers of the Indian species of the genus *Platythyrea* Roger

1. Petiole bidentate posteriorly . . . . *P. sagei* Forest
- Petiole not bidentate posteriorly 2
2. Head elongate (*Cephalic Index < 77), posterior margin deeply excavated . . . . .
. . . . *P. nicobarensis* Forel
- Head not elongate (Cephalic Index > 77), posterior margin shallowly excavated
. . . . *P. parallela* Smith.

*CI=Head width/Head length $\times 100$

Bingham (1903) was the first systematist who laid the foundation for the taxonomic study of Indian Formicidae. A few publications were brought out by subsequent workers from India but none of them paid attention to update the keys or revise the status of the Indian Ponerinae. Chapman and Capco (1951) considered *P. victoriae* as a race of *P. wroughtonii*. Tiwari (1999) listed two species *P. wroughtonii*, and *P. victoriae* as a race of *P. wroughtonii*. However, *P. victoriae* was raised to the species level by Bingham (1903) and both of them were synonymised with *P. parallela* by Brown (1975). This resulted in much confusion for systematists as the synonymising of the species by Brown (1975) was overlooked by Tiwari (1999). Ali (1991) retained *P. wroughtonii* and *P. victoriae* as separate species following Bingham (1903). The recent catalogue of Bolton (1995) included both species as junior synonyms of *P. parallela* and the same is accepted as Tiwari (1999) did not justify his findings in contrast to Brown (1975) and mentioned that 'no material of this species could be made available for study' from South India. The key was reached as I have come across a few individuals of *P. parallela* collected from Bangalore (India), and *P. sagei* collected from Kudremukh National Park (Karnataka) which are present in Southern India.

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Establishment of *Pareuchaetes pseudoinsulata* (Lepidoptera: Arctiidae), an exotic biocontrol agent of the weed, *Chromolaena odorata* (Asteraceae) in the forests of Kerala, India

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ABSTRACT: Larvae of the exotic insect, *Pareuchaetes pseudoinsulata* introduced earlier for biocontrol of the weed, *Chromolaena odorata* were found in good numbers on the weed in Walayar (Palghat Dist.), Nilambur (Malappuram Dist.) and Kottappara (Ernakulam Dist.) in Kerala. Incidence, survival and selective feeding of this insect on the weed suggest further investigations into its utility as a biocontrol agent against *C. odorata* infesting forest plantations. © 2006 Association for Advancement of Entomology

KEYWORDS: *Pareuchaetes pseudoinsulata*, biocontrol, *Chromolaena odorata*, forest plantations

Pareuchaetes pseudoinsulata Rego Barros (Lepidoptera: Arctiidae), earlier known as *Ammalo insulata* (Wlk.), is a native of South America and was introduced into India as a biocontrol agent for the weed *Chromolaena odorata* (=*Eupatorium odoratum*). Large-scale release was carried out on *C. odorata* in Coorg district of Karnataka during 1973 (Sankaran and Sugathan, 1974), but it was reported that the larvae did not establish, mainly due to predation by ants. In 1984, about 40,000 larvae and 400 adults were released in the campus of Kerala Agricultural University in Thrissur, Kerala which resulted in establishment and partial control of the weed in the campus (Joy *et al.*, 1985). Almost during the same period field releases were made in selected centers in Karnataka, Tamil Nadu and Kerala, but no field establishment was recorded (Ahmad, 1991). The biology of *Pareuchaetes pseudoinsulata* has been worked out in detail by Lyla *et al.* (2000). Recently we found infestation of *P. pseudoinsulata* on *C. odorata* in forest plantations in Kerala and the details are reported here.

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FIGURE 1.

FIGURE 2.

FIGURE 3.

Larvae of *P. pseudoinsulata* were found feeding in good numbers on *C. odorata* in the natural forests taken up for enrichment planting at Walayar in Palghat District during July 2005. Observations subsequent to weeding in August 2005 showed that the number of larvae were more on fresh leaves of *C. odorata* in the weeded area than on the leaves of the older plants, indicating the preference of larvae for new flushes. The larvae were collected and reared out successfully in the laboratory on leaves of *C. odorata*. The larvae fed well on *C. odorata* (Fig. 1–3). Mated adults laid eggs in batches, with two females laying a total of 450 eggs during the 6 days of life span. The adults were more active during night and the egg laying was observed mostly at night. In the field, eggs were found on the under surface of *C. odorata* leaves. From July 2005 till last observation in November 2005, a population of *P. pseudoinsulata* was found to survive on *C. odorata* in the plantation area.

In October 2005, *P. pseudoinsulata* larvae were collected from *C. odorata* within a plantation area at Kottappara in Malayattoor Forest Division in Ernakulam District. In November 2005, incidence was noticed at Nilambur in Malappuram District (Mujeeb Rehman, Personal communication).

C. odorata is one of the worst exotic weed species in agriculture, forestry and horticulture, in India. This is the first report of survival of *P. pseudoinsulata* in the Kerala forest, after its field release in 1973 and 1980 as mentioned above. Further systematic survey in the forest plantations and natural forests is necessary to understand the level of establishment of this insect. In Malaysia, recoveries of *P. pseudoinsulata* have been reported far away from the original site of release even 10 years after the releases (Ooi *et al.*, 1988).

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Management of lepidopteran insect predators of lac insect through habitat manipulation

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ABSTRACT: Planting of *Cassia occidentalis* L. (Family: Leguminosae), a medicinal plant, on the periphery of a plot having *Flemingia macrophylla* bushes harbouring lac insects resulted in significant reduction in the population of the two lepidopteran lac insect predators *Eublemma amabilis* Moore (Noctuidae) and *Pseudohypatopa pulverea* Meyr (Blastobasidae) and resulted in significant increase in brood lac yield. The suppression of lac predators may be attributed to higher incidence of *Trichogramma chilonis* Ishi (Hymenoptera: Trichogrammatidae), an egg parasitoid of lepidopteran insects. *T. chilonis* parasitizes the eggs of white butterfly *Catopsilia pyranthe* Linnaeus (Lepidoptera: Pieridae) laid on the leaves of *C. occidentalis* also which favours the build-up of the parasitoid population. © 2006 Association for Advancement of Entomology

KEYWORDS: *Eublemma amabilis, Pseudohypatopa pulverea, Catopsilia pyranthe, Cassia occidentalis, Trichogramma chilonis*

In a survey of the alternative hosts of *Trichogramma chilonis* it was observed that the parasitoid of *E. amabilis* and *P. pulverea* parasitizes the eggs of *Catopsilia pyranthe* Linnaeus (Lepidoptera: Pieridae), a lepidopteran pest of *Cassia occidentalis* L. (Family: Leguminosae), a naturally occurring medicinal plant (Patel and Yadav, 1991). *C. occidentalis* is available in plenty throughout the Chhotanagpur plateau, the major lac growing area of the country. To exploit this natural situation advantageously and to study the effect of interaction, if any, an experiment was conducted at the Indian Lac Research Institute, Ranchi and the results are reported in this paper.

The rainy season *rangeeni* and winter season *kusmi* lac crops were raised during 2004–05 on existing *Flemingia macrophylla* bushes planted at a spacing of 1 × 1 metre in two separate plots of 15 × 10 m area. Each plot consisted of fifteen bushes of *F. macrophylla*. The seedlings of *C. occidentalis* were planted along the periphery of the plots at a distance of one meter. A plot with bushes of *F. macrophylla* having lac encrustation and without *C. occidentalis* at the border was kept as control, far away from the experimental plots. Constant monitoring at weekly interval for two months was carried out to observe the visit of *Catopsila pyranthe* butterflies and its egg laying on the leaves of *C. occidentalis* plants. Eggs laid on leaves were collected

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randomly and kept in test tubes to quantify the magnitude of parasitisation by the egg parasitoid. Samples measuring about 50–60 cm of lac encrustation were collected from each bush and caged in 60 mesh nylon nets at normal room temperature. The samples were allowed to hang from a wire to facilitate proper aeration.

The caged lac crop samples were kept for a period of 30 days to enable the insect predators to emerge out from within the lac encrustations. After the expiry of thirty days, the cages were opened and the population of the two major lac insect predators *E. amabilis* and *P. pulverea* trapped in each nylon bag was counted. The population of predators per meter length of lac encrustation was calculated and recorded. The population of lepidopteran insect predators was compared with control. The yield of lac encrustation in treatment and control plots was also recorded.

The results are presented in Table 1.

Effect of border plants on *kusmi* crop

The population of *E. amabilis* and *P. pulverea* was significantly lower in treatment plots. The percentage reduction in case of *E. amabilis* was 56 while in *P. pulverea* it was 80, in comparison with control. The yield increase was significantly higher (379%).

Effect of border plants on *rangeeni* crop.

Significant reduction in the population of *E. amabilis* and *P pulverea* was observed in *rangeeni* crop also (64.7 % and 62.5%, respectively, over control). The consequent increase in lac yield was 191% higher over control.

Quantification and assessment of natural parasitisation of *T. chilonis*

Eggs of *C. pyranthe* collected from the leaves of *C. occidentalis* were caged in tubes to assess the magnitude of natural parasitisation. The eggs collected from the vicinity of lac crop indicated 22.91 to 55.55 % parasitisation during the period of the experiment.

The parasitizing ability of *T. chilonis* on eggs of *P. pulverea* and *E. amabilis* (Sushil *et al.*, 1999a, b) has already been established under laboratory condition. Effective suppression in the pest population through field release using trichocards has also been reported (Bhattacharya *et al.*, 2003a, b). The eggs of *C. pyranthe* were found heavily parasitized by *T. chilonis* and this facilitated the natural build up of the parasitoid population in the vicinity of plots having lac cultivation. The sustained availability of the egg parasitoid *T. chilonis* in the vicinity throughout the lac crop season enabled to accentuate the number of egg parasitoids and effectively suppressed *E. amabilis* and *P. pulverea* population and resulted increase in lac crop yield. This method assists the lac cultivators in overcoming repeated release of trichocards. This simple strategy of habitat manipulation was found to be economic, eco-friendly and sustainable.

TABLE 1. Effect of planting *Cassia occidentalis* on incidence of lepidopteran lac insect predators and its effect on yield

Lac insect biotype	Treatment	Mean number of *E. amabilis* per metre lac encrustation	Percentage reduction in the incidence of *E. amabilis*	Mean number of *P. pulverea* per metre lac encrustation	Percentage reduction in the incidence of *P. pulverea*	Yield of brood lac per 100g input (g)	Percentage increase in yield over control
Kusmi	Treated	2.80	56.25	1.00	80.00	537	379
		(0–6)		(0–2)		(250–1850)	
	Control	6.40		5.00		112	
		(4–8)		(4–8)		(110–120)	
	SEm±	0.55		0.23		120	
	CD 5%	1.66		0.69		361	
Rangeeni	Treated	4.33	64.68	3.00	62.50	335	191
		(2–9)		(1–6)		(230–450)	
	Control	12.26		8.00		115	
		(10–15)		(5–11)		(100–160)	
	SEm±	0.43		0.44		20	
	CD 5%	1.245		1.27		57	

Figures in parentheses indicate minimum and maximum values.

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Ovicidal and ovipositional effect of *Pedalium murex* Linn. (Pedaliaceae) root extracts on *Dysdercus cingulatus* (Fab.) (Hemiptera: Pyrrhocoridae)

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ABSTRACT: Eggs of *Dysdercus cingulatus* (Fab.) (Hemiptera: Pyrrhocoridae) were treated with *Pedalium murex* Linn. (Pedalaceae) root ethanol extract along with neemgold and water to find out their ovicidal action and effect on ovipositional activities. Neemgold was more toxic to the eggs of *D. cingulatus* than *P. murex* root extract. *P. murex* treatment delayed the pre-mating period, period between mating and egg laying, ovipositional time, number of egg laid and hatching percentage, male and female adult longevity and adult weight compared to neemgold and control. Qualitative phytochemical analysis of *P. murex* root extract revealed that it contains steroids, terpenoids, phenol compounds, saponines, tannins and flavanoids.
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KEYWORDS: *Dysdercus cingulatus*, *Pedalium murex*, ovicidal, ovipositional effect, phytochemistry

Dysdercus cingulatus (Fab.) (Hemiptera: Pyrrhocoridae) is a serious pest of cotton and distributed in all the cotton growing regions of India (David and Ananthakrishnan 2004). Rajendran and Gopalan (1980) reported that extracts of *Catharanthus roseus* (Linn.) G. Don. (Asteraceaae), *Parthenium hysterophorus* Don (Apocynaceae) and *Nephrolepis exaltates* (L.) Schott (Nephrolepidaceae) caused morphological change in *D. cingulatus*. Impact of neem extracts (Gawande and Burkhade 1989) and neem derived pesticide, neemgold (Abraham and Ambika, 1979) on moulting and vitellogenesis of *D. cingulatus* were observed. Economic importance (Paul and Paria, 1986), basic chemical constituents (Bhakuni and Shukla, 1992), ovicidal and ovipositional effects of *Pedalium murex* Linn. (Pedalaceae) on *Dysdercus* spp. (Gahukar, 1995) were reported earlier. The present investigation was undertaken to evaluate the ovicidal effect and the effect on the ovipositional behaviour caused by *P. murex* root ethanol extract on *D. cingulatus*. Preliminary phytochemical constituents of *P. murex* were also observed.

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Nymphs and adults of *D. cingulatus* were maintained under laboratory condition (27 ± 2°C; 70–75% RH; 11L and 13D) in plastic containers with soaked cottonseeds and fresh cotton leaves. Laboratory emerged adults (>3 hrs) and their eggs (>12 hrs) respectively were used for the present study. The roots of *P. murex* were removed and washed thrice with distilled water and shade dried for two weeks. Two hundred gm of dried root was extracted with 500 ml of ethanol using soxhlet apparatus for 24 hrs at 50–60 °C. Ethanol extract was concentrated by distillation at 40 °C and the crude extract was used for this study. Presence of secondary metablities *viz.*, steroids, phenolic compounds, saponin, xanthoprotein, alkaloids, triterpernoids, tannins, and flavanoids have been tested using the standard procedures of Brindha *et al.* (1981).

Thirty laboratory laid *D. cingulatus* eggs each were collected, spread over the filter paper (2×2 cm) uniformly, and 1 ml of each plant extract (0.1, 0.2, 0.4 and 0.8%) was sprayed separately over the eggs. Control (water alone) and standard (neemgold −3% Sourthern Petrochemical Industries Corporation Ltd, Chennai) were also maintained. For each treatment, three replications were maintained. Time taken for the egg colour change, the egg mortality and hatching percentage were recorded.

In another experiment, fresh cotton leaves were sprayed with *P. murex* root ethanol extract (2 ml) at different concentrations (0.1, 0.2, 0.4 and 0.8 %) separately. Then the leaves were shade dried for 5 minutes and placed in plastic containers. A pair of newly emerged *D. cingulatus* was collected from the stock culture and released into the container. The containers were covered with muslin cloth and provided with 10–15 water soaked cottonseeds. Control and standard were provided with cotton leaves sprayed with water and neemgold (3%) respectively. Observations on the premating period (in days), mating time (in min.), egg-laying period (in days) and number of eggs laid by a female were recorded. The eggs laid by each female were collected daily from the container and maintained separately in a filme vial (35 ml) for hatching. The percentage ovipositional repellency of the plant extract was calculated by using the following formula: Ovipositional repellency (%) = Total number of egg laid in control X Total number of egg laid in treatment/Total number of egg laid in control $\times$ 100.

The adult longevity of both the male and female were recorded for each treatment separately. Immediately after the death, weight of both male and female were recorded. Student '*t*' test was performed between the control and the standard and also for each treatment separately and the significance was expressed at 5% level.

The result presented in Table 1 showed that in comparision with control, neemgold treatment significantly prolonged mating duration and reduced fecundity, hatchability and male and female longivity. All doses of *P. murex* significantly increase the mating duration and hatching percentage while the fecundity, male adult longivity were significantly lowerd 0.8% of *P. murex* extract and female adult longivity was significantly lower than in control in 0.4 and 0.8% extract. Though premating period was not significantly altered by neemgold all the doses of *P. murex* extract significantly increased the premating period of *D. cingulatus*. Egg laying period not affected by neemgold was significantly shortened by 0.4 and 0.8% extract of *P. murex*. Incubatoin period of *D. cingulatus* egg unaffected by neemgold was significantly prolonged by 0.8% of *P. murex* extract.

TABLE I. Impact of *P. murex* on the mating, oviposition and egg biology of *D. cingulatus*

Parameters	Control	Standard (neemgold)	Concentrations (in %)			
			0.1	0.2	0.4	0.8
Premating period	2.0 ± 0	3.0 ± 0	4.7 ± 0.5*	4.9 ± 0.3*	5.3 ± 0.5*	6.0 ± 0.8*
Mating duration	76.6 ± 11.05	106.6 ± 11.05*	83.3 ± 11.05*	98.3 ± 10.6*	103.3 ± 9.42*	108.3 ± 12.4*
Egg laying period	2.0 ± 0	1.2 ± 0.4	1.5 ± 0.5	1.5 ± 0.5	1.0 ± 0.1*	0.8 ± 0.3*
No. of eggs laid/female	136.8 ± 3.12	44.5 ± 8.01*	127 ± 1.62	69 ± 3.34	81.2 ± 1.31	64.32 ± 1.26*
Incubation period (in days)	5.33 ± 0.94	6.5 ± 0.95	5.33 ± 0.94	5.66 ± 0.74	5.83 ± 0.68	7.5 ± 1.25*
Hatching percentage	90.5 ± 11.47	16.25 ± 2.19*	51.66 ± 0.86*	50.0 ± 2.60*	25.6 ± 3.92*	25.0 ± 0.71*
Male adult longevity	15.0 ± 0.26	13.0 ± 0.5*	15.0 ± 0.26	14.5 ± 0.23	14.0 ± 0.20	12.5 ± 0.15*
Female adult longevity	8.2 ± 0.8	5.1 ± 0.1*	8.0 ± 0	7.5 ± 0.6	6.5 ± 0.10*	6.0 ± 0.15*

*Shows significant at 5% by student '*t*' test.

In earlier reports also it was seen that neem products inhibit the reproductive behaviour in red cotton bugs, *Dysdercus* spp. (Koul, 1984; Katiyar and Srivastava, 1984) and vitellogenegis in *D. cingulatus* (Abraham and Ambika, 1979). Chakraborti and Chatterjee (1999) reported that though the effect of *P. murex* on ovarian development of *D. koenigii* was not clearly known, it might affect mating, egg maturation, and egg laying. The preliminary phytochemical analysis of *P. murex* revealed that the extract contains steroid, reducing sugars, phenolic compounds, saponins xanthoprotein, alkaloids, triterpeniod, tannins and flavanoids. These may be causing the adverse effects on *D. cingulatus*. Thus in overall assesment of *P. murex* extract was performing better than neemgold relation to the adverse effect on the behaviour and development of *D. cingulatus*.

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Comparative performance of some bivoltine silkworm (*Bombyx mori* L.) hybrids

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ABSTRACT: The high levels of production and productivity achieved by many sericulturaly-advanced countries is mainly attributed to use of highly productive silkworm hybrids for commercial silk production.
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Attempts to evolve new and more productive breeds/hybrids suited to agro-climatic conditions of J & K state, resulted in the evolution of a productive hybrid namely SKAU-HR-1 which subsequently was authorized for commercial exploitation in temperate areas of J & K state (Kamili, 1996). Since the parental stocks of hybrid combination undergo some deterioration in performance due to continuous inbreeding, evolution/identification of new, vigorous and more productive breeds/hybrids must be a continuous programme so that week and deteriorated breeds/hybrids are replaced with new and more productive ones as and when need arises.

The present study was, therefore, undertaken to evaluate new hybrids (short listed as some of the promising hybrids in earlier studies (Malik *et al.*, 1998, 2001)) in comparison to popular hybrid, $SH_6 \times NB_4D_2$, currently used in the field.

Five hybrids *viz.*, SKAU-R-1 × KA, $NB_4D_2 \times C122$, KA× Changnaung, SKAU-R-6 × Sheiki and SKAU-R-6 × KA were tested along with popular commercial hybrid, $NB_4D_2 \times SH_6$ (as standard check), were reared at the Division of Sericulture, Mirgund during April–May, 2002. The experiment was done in a completely randomized design with four replications for each treatment. Each replication comprised 250 worms (after 3rd moult). Standard rearing techniques suggested by Krishnaswami (1978) were followed in this study. The data were collected on 7 metric traits viz., single cocoon weight, single shell weight, shell ratio %, yield/10,000 larvae (wt.), ERR%, V instar

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TABLE 1. Comparative performance of some silkworm (*Bombyx mori* L.) hybrids

Hybrids	Single Cocoon wt. (cg)	Single Shell wt. (cg)	Shell ratio (%)	Yield/10,000 larvae (after 3rd moult) Wt (kg)	ERR (%)	V Instar larval period (Days)	Silk productivity (cg)/day	EI values			Average EI
								Single shell wt.	Shell ratio	Silk productivity/ day	
SKAU-R-1 × KA	208	46*	22.12*	18.800	85.10	7.21	5.429*	64.3	67.7	59.4	63.8
NB4D2 × C122	221	42*	18.86	21.130	87.20	6.79	5.386*	50.0	44.4	57.9	50.8
KA × Changnaung	217	39	18.26	18.730	86.90	6.71	5.051*	39.2	40.1	45.9	41.3
SKAU-R-6 × Sheiki	214	41	19.46	18.470	85.70	6.71	5.237*	46.6	48.7	52.6	49.2
SKAU-R-6 × KA	212	45*	20.28*	18.270	84.70	7.29	5.228*	60.8	54.6	52.2	55.9
NB4D2 × SH6 (check)	210	40	18.84	19.000	83.90	7.25	4.661	42.8	44.3	32.1	39.7
CD at $P = 0.05$	NS	1.98	1.24	NS	NS	NS	0.360	–	–	–	–

*Significant at $P = 0.05$ NS = Non significant

period and silk productivity. Silk productivity was computed by using the following formula: (Udupa and Gowda, 1988).

Silk productivity/day (cg) = ERR (%) × cocoon shell weight (cg)/V instar period (days).

The data recorded/calculated was subjected to analysis of variance. Traits which exhibited significant differences were utilized for computation of evaluation index (EI) values by the following formula $EI = (A - B/C)10 + 50$. Where A = Value of a particular hybrid, B = Mean value, C = Standard deviation, 10 = Standard unit and 50 = Fixed value. (Mano *et al.*, 1993).

EI values of each trait were added up to work out average index (EI) values for each hybrid. EI value fixed for the selection of a hybrid was 50. Hybrids which scored above this value were considered to possess greater potential.

Analysis of variance carried out for 7 metric traits (Table 1) indicated presence of significant differences between hybrids for 3 traits only viz., single shell weight, shell ratio % and silk productivity. In all other traits treatments were on par with check.

SKAU-R-1 × KA, SKAU-R-6 × KA and NB_4D_2 × C122 with shell weights of 46, 45 and 42 cg respectively were significantly superior to check. Although minimum shell weight (39 cg) was recorded in KA × Changnaung, yet it was similar to check. In shell ratio (%) only SKAU-R-1 × KA (22.12) and SKAU-R-6 × KA (20.28) were significantly superior to check. Silk productivity ranged from 4.66 NB_4D_2 × SH_6) to 5.429 cg/day of Vth instar period.

Silk productivity was reported earlier as one of the breeding indices to evaluate silkworm breeds and their single, double and three way hybrids (Udupa and Gowda, 1988; Singh, 2002). In the present study all the five hybrids were superior to check, in silk productivity at 0.05 level of significance, although there was no significant difference between these hybrids in Vth instar period and ERR (%)-two important component traits of silk productivity. Cocoon/silk yield being a complex trait is contributed by more than 21 component traits (Thiagarajan *et al.*, 1993). Hence identification of new and productive breeds/hybrids calls for consideration of cumulative effects of all the component traits on cocoon silk yield. Multiple trait evaluation method developed by Mano *et al.*, 1993 is a simple non-parametric method which has been utilized successfully by several workers (Bhargava *et al.*, 1994; Rajalakshmi *et al.*, 2000) for evaluation of silkworm genotypes. In this method equal weightage is given to all yield component traits whether they show significant difference or not. However in the present study only those traits were considered for computation of EI values which showed significant differences between treatments as indicated by F- test. In the present set of hybrids three scored EI values above 50. These hybrids in order of merit were, SKAU-R-1 × KA (63.8), SKAU-R-6 × KA (55.9) and NB_4D_2 × C122 (50.8). These hybrids thus deserve to be included in multilocational trials prior to their commercial exploitation as they have out performed the commercial hybrid appreciably.

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Evaluation of milking and electric shock methods for venom collection from hunter reduviids

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ABSTRACT: Milking and electric shock methods were used for collecting the venom from *Rhynocoris marginatus* (Fab.) and *Catamiarus brevipennis* (Serville). Milking was better than electric shock for continuous collection of venom. Irrespective of the collection method and species tested, females yielded more venom than the males. The milking may be applicable to other predatory bugs.
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KEYWORDS: Reduviid predator, Venom collection methods

The venom of the poisonous predators is an important source for novel peptides with a notable potential for use in agriculture and medicine. Three methods are commonly used for collecting venom: extracts of the whose body, dissection of venom glands (Ambrose and Maran, 1999) and milking (Piek, 1986; Deyrup and Matthews, 2003). Among these methods, milking is the most popular for collecting pure venom (Deyrup and Matthews, 2003). Very little information is available on the venom of reduviid predators and its physiological role and no information is available on venom collection methods. In this study, an attempt was made to collect the venom from both sex of *Rhynocoris marginatus* (Fab.) and *Catamiarus brevipennis* (Serville) by using two methods, *viz.*, milking and electric shock. The protein content of the venom of male and female was also determined.

Life stages of *C. brevipennis* and *R. marginatus* were collected from the border of cotton agro-ecosystem at Vallanadu, Killikulam near Agriculture College and Research Station, Tirunelveli District, Tamil Nadu. They were reared in plastic containers (7 × 6 cm) under laboratory conditions (28 ± 2 °C; 70–80% RH) on *Corcyra cephalonica* larvae (5–8 larvae/day/predator). *R. marginatus* is medium sized whereas *C. previpennis* is large sized. Both are polyphagous hunter reduviids and in both species, the females are significantly heavier than males (see Table 1). Thirty newly hatched adults (15 males and 15 females) were individually subjected to starvation

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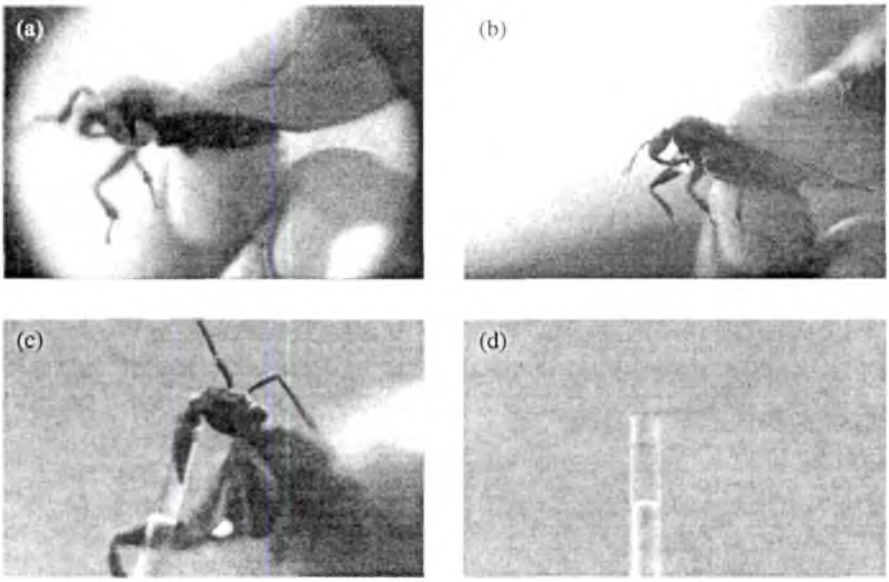

FIGURE 1. Venon milking procedure: Holding procedure of predator – a; Spliting of saliva –b; Collection of venon – c; and Collected venon –d.

for one day. The weight of the predator and a capillary tube were recorded and then the venom was collected by milking method using the capillary tube. To milk the venom *C. brevipennis* was held between two fingers—thumb on the ventral side of the abdomen and second finger on the dorsal side. Care was taken not to crush the bug during handling. Sixty percent of *C. brevepennis* immediately spit the saliva, whereas *R. marginatus* did not show such behaviour. Then the glass capillary tube (3 cm long, 2 mm outer diameter and 1 mm inner diameter) was inserted onto the tip of the rostrum. By gently pressing with the fingers, the insect was stimulated to insert the rostrum deeper into the capillary tube and eject the venom from the salivary gland. During this act, the venom flowed from the tip of the rostrum as a thin drop of liquid into the capillary tube. A 1.0 ml capacity microcentrifuge tube was placed on the other end of capillary tube for collecting the exuded venom. The act of pressing the abdomen was made twice or thrice, with an interval of 5–10 seconds. The collection of the venom stimulated additional venom flow, as a result of either the pull on the capillary tube into the rostrum up to the second segment (or) the contact of the finger on abdominal hairs.

In electric shock method, instead of holding the reduviid with fingers, the predator was held with a forceps attached with the electric shock-inducer (Mahaleshmi Electric and Co, Tamil Nadu). After holding the reduviid, electric stimulus (180–230 volts) was passed into the abdominal sternal region either between fourth and fifth segment or fifth and sixth segments. The shock was given two or three times during one milking.

TABLE 1. Venom yield from males and females of *R. marginatus* and *C. brevipennis* using milking and electric shock methods

Inspect species	Sex	Body weight (mg)	Milking method (MM)		Electric shock method (ESM)	
			Quantity of venom (mg)	Protein content of venom (mg/ml)	Quantity of venom (mg)	Protein content of venom (mg/ml)
R. marginatus	Male	139.09 ± 6.55	0.39 ± 0.05	23.78	$0.70 \pm 0.02*$	22.08
	Female	$207.96 \pm 5.47^{+}$	$0.53 \pm 0.03^{+}$	53.94	$1.53 \pm 0.05^{+*}$	51.74
C. brevipennis	Male	516.99 ± 2.84	4.16 ± 1.137	27.86	$6.18 \pm 0.72^{*}$	25.41
	Female	$624.81 \pm 2.90^{+}$	$8.87 \pm 1.37^{+}$	86.32	$9.89 \pm 1.13^{+}$	84.02

Significance shown at 5% level (+ between male and female and * between two methods of the same species).

After the venom collection, the weight of predator and capillary tube were recorded to quantify the amount of venom. Subsequently 5 μl of phosphate buffer was added to the venom and stored in refrigerator for further use. Protein content of the venom was estimated following the method of Lowry *et al.* (1951) using Bovine Serum Albumen as standard.

Effect of sex, weight and venom collection method on the venom yield is shown in Table 1. Irrespective of the species and the method of collection, the female yielded more venom than the male. Total protein content of the venom was higher in female than the male (Table 1).

In the electric shock method it was very difficult to subject the insect to electric stimulus. The insect invariably died within 72 h after electric shock. The insect does not feed after the electric shock and scar is formed at the site of electric shock. Although the electric shock method yielded more quantities of venom in both insects (Table 1), because of the above disadvantages, milking method is preferable. It can be used for repeated collection of venom and moreover is simple to carry out.

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Selection of effective insecticides and less susceptible rice varieties for the control of rice panicle mite, *Steneotarsonemus spinki* smiley

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ABSTRACT: Thirteen pesticides were evaluated for their bio-efficacy against *S. spinki* under net-house condition during *Kharif*-2002 and *rabi*-2003. Profenofos was best pesticide recording no living mite population in both seasons. Treatments like acephate, BPMC, dimethoate monocrotophos, insulf, oartap and dicofol did not give absolute control but reduced the mite population significantly when compared to untreated control. Other pesticides did not show significant differences with control. Varietal reaction of 22 commonly grown rice varieties studies under artificial infestation on the potted plants using parameters as mite population/tiller at heading stage, mite population/100 grains at the time of maturation and also grain sterility per cent revealed that Ramaboita was most resistant. Tapaswini was highly susceptible followed by scented varieties Kalajoha, Taraodi Basmati, Pusa Basmati-1 and Basmati-370. Vanaprabha, Heera, Annada and Vandana were tolerant.
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KEYWORDS: Panicle mite, *Steneotarsonemus spinki*, profenofos, acephate, dimethoate, varietal reaction

INTRODUCTION

There is a need to develop an effective and economic package of practices to minimize sterility in rice caused by the panicle mites in India. An effective chemical acaracide is one of the important means to control the pest. No suitable acaracide is yet recommended for control of rice panicle mites. Hence, bio-efficacy of certain pesticides was studied under net-house condition, using artificial infestation of *Steneotarsonemus spinski*. The reaction of common rice varieties to this pest was also worked out.

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TABLE 1. Mite population in rice 72 h after pesticidal treatments

Sl. No.	Pesticide	Conc. (%)	Mite pp/tiller* Kharif-2002		Mite pp/tiller* Rabi-2003	
1.	Omite 57EC	0.10	15.03	(225.50)	11.22	(125.50)
2.	Profenofos (Curacron) 50 EC	0.10	0.70	(00.00)	0.70	(00.00)
3.	Insulf (Sulphur 80% WP)	0.15	6.76	(45.25)	6.22	(38.25)
4.	Dicofol 18.5% EC	0.10	12.28	(150.50)	11.87	(140.50)
5.	Carbosulfan (Marshal) 25 EC	0.10	15.68	(245.50)	15.45	(238.50)
6.	BPMC (Bipivin) 50EC	0.10	5.56	(30.50)	4.97	(24.25)
7.	Ethofenprox (Nukil) 10 EC	0.02	14.16	(200.25)	10.80	(116.25)
8.	Fipronil (Regent) 5 SC	0.01	15.98	(255.00)	15.98	(255.00)
9.	Monocrotophos (Nuvacron) 36 WSC	0.10	5.09	(25.50)	5.09	(25.50)
10.	Acephate (Starthene) 75 WP	0.15	3.74	(13.50)	3.31	(10.50)
11.	Cartap (Patap) 25 WP	0.10	7.81	(60.50)	16.15	(260.50)
12.	Carbaryl (Sevin) 50 EC	0.15	16.27	(264.50)	15.96	(254.25)
13.	Dimethoate (Rogor) 50 EC	0.10	5.97	(35.25)	4.66	(21.25)
14.	Control	–	17.04	(290.00)	17.19	(295.00)
	Cd at 5%		4.12			3.95
	SEM ±		1.47			1.43

$* = \sqrt{X = 0.5}$ transformation of original live mite population/tiller in parentheses.

MATERIAL AND METHODS

Thirteen pesticides, which are commonly used against rice pests, were evaluated under net-house condition during *Kharif*-2002 and *rabi*-2003. Seedlings of variety Ratna were grown and transplanted in the earthen pots @2 seedlings/pot. Twenty days after transplanting, mites were introduced on the potted plants (inoculation 100 mites/plant using common-plug method). Pesticidal treatment Table 1 was given as run-off spray 30 days after mite release. Number of living adult and nymphal stags of mites/tiller was recorded 72 h after pesticidal treatment. Data thus obtained were analyzed statistically. For varietal screening 100 panicle mites/plant were inoculated 10 days after transplanting in each pot and was kept covered with the nylon cage to avoid infestation by other mites and insects, and the plants were allowed to grow-up to grain maturation. Ten replications were treatment maintained for each. Mite population/tiller at heading; mite population/100 grains and also number of sterile grains at maturation were recorded. Experiment was repeated during *kharif*-2002 to conform the results.

RESULTS

Data in Table 1 revealed that profenofos was most superior pesticide recording 100 per cent kill of the test mite population during both seasons. Acephate, BPMC,

TABLE 2. Varietal reaction to rice panicle mite during kharif-2001 (A) & 2002 (B)

Sl. No.	Vvariety	A Mite pp/tiller at heading state*	A Mite pp/100 grains*	A %grain sterility**	B Mite pp/tiller at heading stage*	B Mite pp/100 grains*	B %grain sterility**
1.	Taradoi Basmati	16.04 (256.80)	1.56 (1.80)	20.79 (20.60)	16.26 (264.20)	4.43 (19.20)	28.52 (22.80)
2.	Kalajoha	16.10 (259.00)	3.88 (14.00)	28.52 (22.80)	16.50 (272.00)	4.30 (18.00)	28.79 (23.20)
3.	Basmati-370	15.85 (251.20)	4.67 (21.00)	20.96 (20.80)	16.26 (264.20)	4.61 (20.80)	27.28 (21.00)
4.	Pusa Basmati-1	15.93 (253.40)	5.78 (33.00)	28.66 (23.00)	15.83 (250.40)	5.52 (30.00)	27.97 (22.00)
5.	Heera	2.34 (5.00)	1.58 (2.00)	9.63 (2.80)	2.91 (8.00)	1.70 (2.40)	9.98 (3.00)
6.	Kalinga III	5.73 (32.40)	2.30 (4.80)	13.18 (5.20)	6.39 (40.40)	2.12 (4.00)	14.18 (6.00)
7.	Vandana	2.66 (6.60)	0.70 (0.00)	9.98 (3.00)	3.24 (10.00)	0.70 (0.00)	11.54 (4.00)
8.	Vanaprabha	1.30 (1.20)	0.70 (0.00)	8.53 (2.20)	1.58 (2.00)	0.70 (0.00)	11.54 (4.00)
9.	Radhi	4.46 (19.40)	2.73 (7.00)	15.12 (6.80)	4.94 (24.00)	2.91 (8.00)	14.18 (6.00)
10.	Dhaula Heera	4.25 (17.60)	3.33 (10.60)	15.79 (7.40)	4.61 (20.80)	2.70 (6.80)	17.46 (9.00)
11.	Annada	3.11 (9.20)	1.81 (2.80)	9.63 (2.80)	3.53 (12.00)	1.87 (3.00)	8.18 (2.00)
12.	Tapaswini	16.27 (264.40)	5.97 (35.20)	33.09 (29.80)	15.52 (240.40)	5.54 (30.20)	29.33 (24.00)
13.	Lalat	6.62 (43.40)	4.39 (18.80)	16.64 (8.20)	7.74 (52.00)	4.52 (20.00)	18.44 (10.00)
14.	Ramaboita	0.70 (0.00)	0.70 (0.00)	2.00 (0.00)	0.70 (0.00)	0.70 (0.00)	1.70 (0.00)
15.	Vijeta	16.06 (255.60)	5.78 (33.00)	30.13 (25.20)	15.34 (235.10)	5.33 (28.00)	27.40 (21.20)
16.	Sambha Massurie	15.79 (248.90)	5.73 (32.40)	29.20 (23.80)	15.44 (238.10)	4.98 (24.40)	28.11 (22.20)
17.	Pooja	15.18 (230.20)	5.61 (31.00)	25.99 (19.20)	15.38 (236.20)	5.31 (27.70)	28.11 (22.20)
18.	Savitri	15.60 (243.00)	5.95 (35.00)	28.18 (22.30)	15.37 (236.00)	5.19 (26.50)	28.73 (23.10)
19.	Gayatri	14.85 (220.10)	5.01 (24.70)	25.84 (19.00)	15.01 (225.10)	4.75 (22.10)	25.81 (19.00)
20.	Udaya	10.51 (110.00)	3.40 (11.10)	18.63 (10.20)	11.11 (123.00)	3.59 (12.40)	22.93 (15.20)
21.	Sneha	10.27 (105.00)	3.24 (10.00)	15.00 (6.70)	10.71 (114.40)	3.57 (12.30)	21.89 (13.90)
22.	Ratna (Susceptible check)	21.05 (442.80)	6.69 (44.30)	33.46 (30.40)	21.96 (482.00)	6.87 (46.80)	34.45 (32.00)
	CD at 5%	2.01	0.81	2.13	2.23	0.91	2.34
	CD at 1%	2.81	1.18	2.97	3.01	1.31	3.11
	SEM ±	0.73	0.29	0.79	0.77	0.33	0.82

0 mite/tiller = Resistant; 1–10 mites/tiller = Tolerant; 11–50 mites/tiller = Susceptible, 51 and above mite/tiler = Highly susceptible. $*$ = $\sqrt{X} + 0.5$ values of original data presented in parenthesis. $**$ = Angular transformation of original values in parenthesis.

dimethoate, monocrotophos, insulf, cartap and dicofol significantly reduced the mite population as compared to untreated control.

Mite population per tiller at heading stage, mite population/100 grains at the time of maturation and also per cent grain sterility (Table 2) revealed that Ramaboita (a local variety from Jaipur, Orissa) was free from the infestation of this mite at heading stage and also no mite was recorded in the grain at maturation and thus showed lowest sterility in both the seasons. Varieties *viz.*, Vanaprabha, Heera, Annada and Vandana were tolerant harbouring significantly less mite population compared to susceptible check Ratna. Tapaswini, a lowland variety was highly susceptible having 264 mites/tiler at heading stage and a population of 35.20 mite/100 grain at maturation (kharif-2001) and 240 mites/tiller (kharif-2002), followed by scented varieties Kalajoha, Taraodi Basmati, Pusa Basmati-1 and Basmati-370. Results are comparable with earlier report on mite population and grain sterility in variety Ratna, which is known to be highly susceptible to this mite (Rao and Prakash, 1995).

DISCUSSION

For the first time pesticides have been evaluated under artificial infestation of rice panicle mite using common plug method, which is considered as the most reliable method for screening of the pesticides or rice varieties against tarsonemid mites under controlled contain (Rao *et al.*, 1999). In an earlier study, the efficiency of six pesticides *viz.*, dimethoate, oxydemeton methyl, phosphomidon, kelthane, pyrochlorophos and methyl parathion was worked out in laboratory using artificially infested rice stem pieces and dimethoate (0.04% spray) was found to be most effective pesticide against *S. spinki* (Ghosh *et al.*, 1998). In present study, dimethoate was found effective against the mite but was ranked at 5th position following profenofos, acephate, monocrotophos and BPMC.

Ramaboita was free from the mite infestation in both the seasons and consequently showed lowest sterility at grain maturation. Present study on reaction of these rice varieties to rice panicle mite, *S. spinki* appears to be the first report.

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A new whitefly species of the Genus *Taiwanaleyrodes* Takahashi (Homoptera: Aleyrodidae) from Western Ghats of South India

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ABSTRACT: In the taxonomic study of whiteflies of Indian subcontinent a new species *Taiwanaleyrodes tripori* was found to occur in western ghats of South India which is described and illustrated. A key to the Indian species of genus *Taiwanaleyrodes* Takahashi is also presented. © 2006 Association for Advancement of Entomology

KEYWORDS: Aleyrodids, whiteflies, new species, *Taiwanaleyrodes tripori*, western ghats

INTRODUCTION

The family Aleyrodidae includes insects which are commonly known as whiteflies. They are an economically important groups of insects infesting a wide range of host plants (Mound and Halsey, 1978). Among the various genera of subfamily Aleyrodinae of the family Aleyrodidae the genus *Taiwanaleyrodes* was erected by Takahashi in 1932. This genus is represented by two species viz., *T. fletcheri* Sundararaj and David and *T. indica* (Singh) in India. An extensive survey and taxonomic study of the whiteflies of western ghats of south India conducted during 2001–2003 revealed the occurrence of a new species belonging to this genus which is described and illustrated here.

Taiwanaleyrodes tripori sp. nov. (Fig. 1)

Pupal case

Small, white with secretion of little wax; elliptical, broadest at the metathoracic region, narrowing towards the caudal end (Fig. 1): found singly, one or two per leaf on the under surface of leaves; 0.54–0.56 mm long and 0.2–0.34 mm wide.

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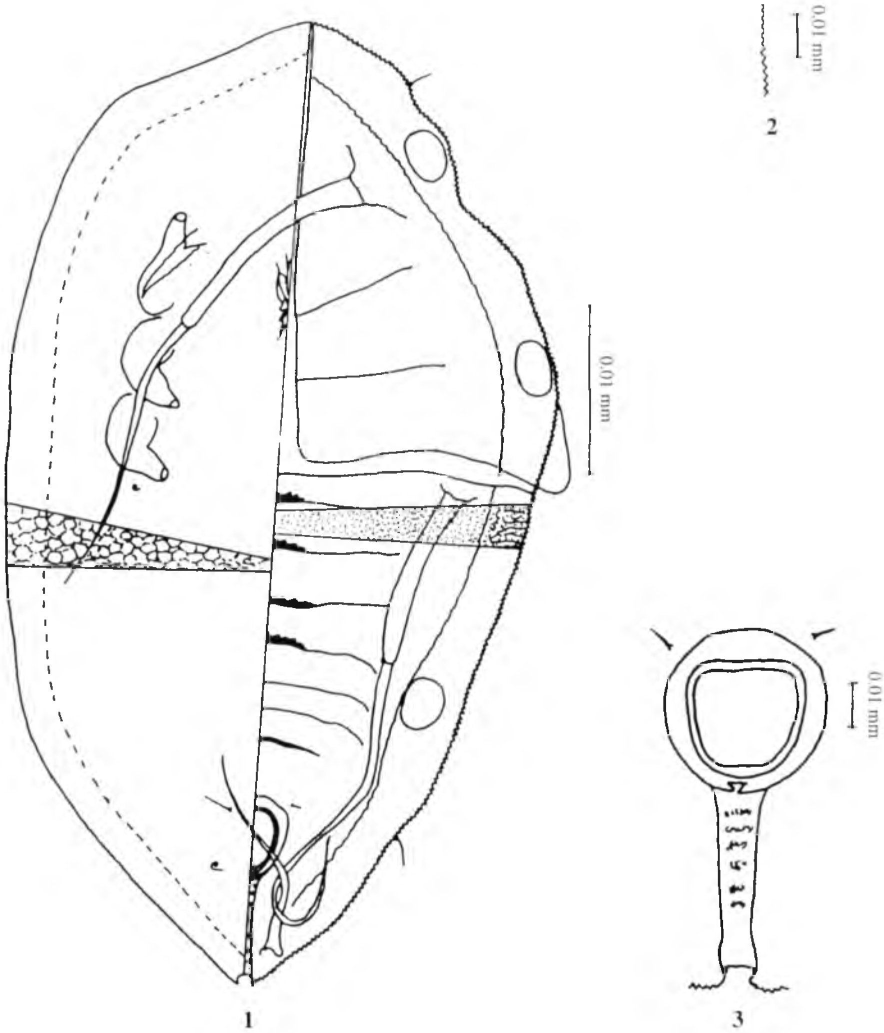

FIGURES 1–3: *Taiwanaleyrodes tripori* sp. nov. (1) Pupal case: (2) Margin: (3) Vasiform orifice with caudal furrow.

Margin

Faintly crenulate, 38–72 crenulations in 0.1 mm. Anterior and posterior marginal setae respectively, 16 and 3 μm (Broken) long. Thoracic tracheal combs and pores wanting while caudal tracheal pore indicated by invagination (Figs 2, 3).

Dorsal surface

Dorsum with four pairs of setae-cephalic setae 360 μm long, first abdominal setae 340 μm long, eighth abdominal setae 7 μm long and a pair of submarginal caudal setae 166 μm long, dorsum completely granulated. Submargin with three pairs of large subcircular lobes, two pairs on cephalothorax- one pair each on pro- and mesothoracic segments region and one pair on forth abdominal segment region, submarginal striations evident. Abdominal segment I–IV with distinct median tubercles which extend in rows along the sutures on submedian area; minute tubercles along pro- meso- and metathoracic segments sutures absent. Median length of VII abdominal segment shorter than VIII.

Vasiform orifice cordate and deeply invaginated at the caudal end, longer than wide, 48–54 μm long and 46–47 μm wide; operculum cordate, 24–32 μm long and 30–32 μm wide, filling the orifice and obscuring the lingula. Caudal furrow cylindrical with faint granulations, 52 μm long and 18 μm wide at its broadest end (Fig. 3), thoracic tracheal furrows not discernible.

Ventral surface

A pair of ventral abdominal setae 12 μm long and 25 μm apart; thoracic and caudal tracheal folds absent; ventral surface with semicircular or polygonal markings. Antennae reaching at the base of prothoracic legs (Fig. 1).

Host

Unidentified plant.

Specimens examined: Holotype

One pupal case on slide, on unidentified plant, Wayanad Wildlife Sanctuary (Palkad district: Kerala), India, 26.iii.2001, Coll: A. K. Dubey. The holotype is deposited in Zoological Survey of India. Chennai. Paratypes: Eight pupal cases on slides, data as on holotype, to be deposited in the Division of Entomology, Indian Agricultural Research Institute, Pusa Campus, New Delhi. Department of Entomology, in the collections of the Systematic Entomology Laboratory, United States Department of Agriculture, Beltsville, Maryland, U.S.A. The Natural History Museum, London U.K. and the types are also available with authors.

Remarks

Fundamentally, this species resembles to *Taiwanaleyrodes fletcheri* Sundararaj and David by the presence of median tubercles and granulated subdorsum but quite differs from it in having three pairs of large subcircular lobes on submargin and less number of median tubercles on abdomen and by the absences of minute tubercles on cephalothorax. This species is distinct from all other known species of *Taiwanaleyrodes* by the presence of three pair of subcircular lobes on submargin.

Etymology

This species name describes the presence of three pairs of large subcircular lobes on submargin.

Key to Indian species of *Taiwanaleyrodes* Takahashi

1. Abdominal segments with median tubercles; subdorsum with granules: vasiform orifice cordate 2
- Abdominal segments without median tubercles; subdorsum without granules: vasiform orifice subcircular . . . . *indica* (Singh)
2. Submargin with large subcircular lobes; abdominal segments 1–4 with median tubercles . . . . *tripori* sp. nov.
- Submargin without large subcircular lobes: abdominal segments 1–7 with median tubercles . . . . *fletcheri* Sundararaj & David

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